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Machinery That Meets the Requirements for Stubble-Mulch Tillage
G. E. Ryerson, R. R. Poynor, A. H. Keller, H. E. Pinches, R. M. Merrill

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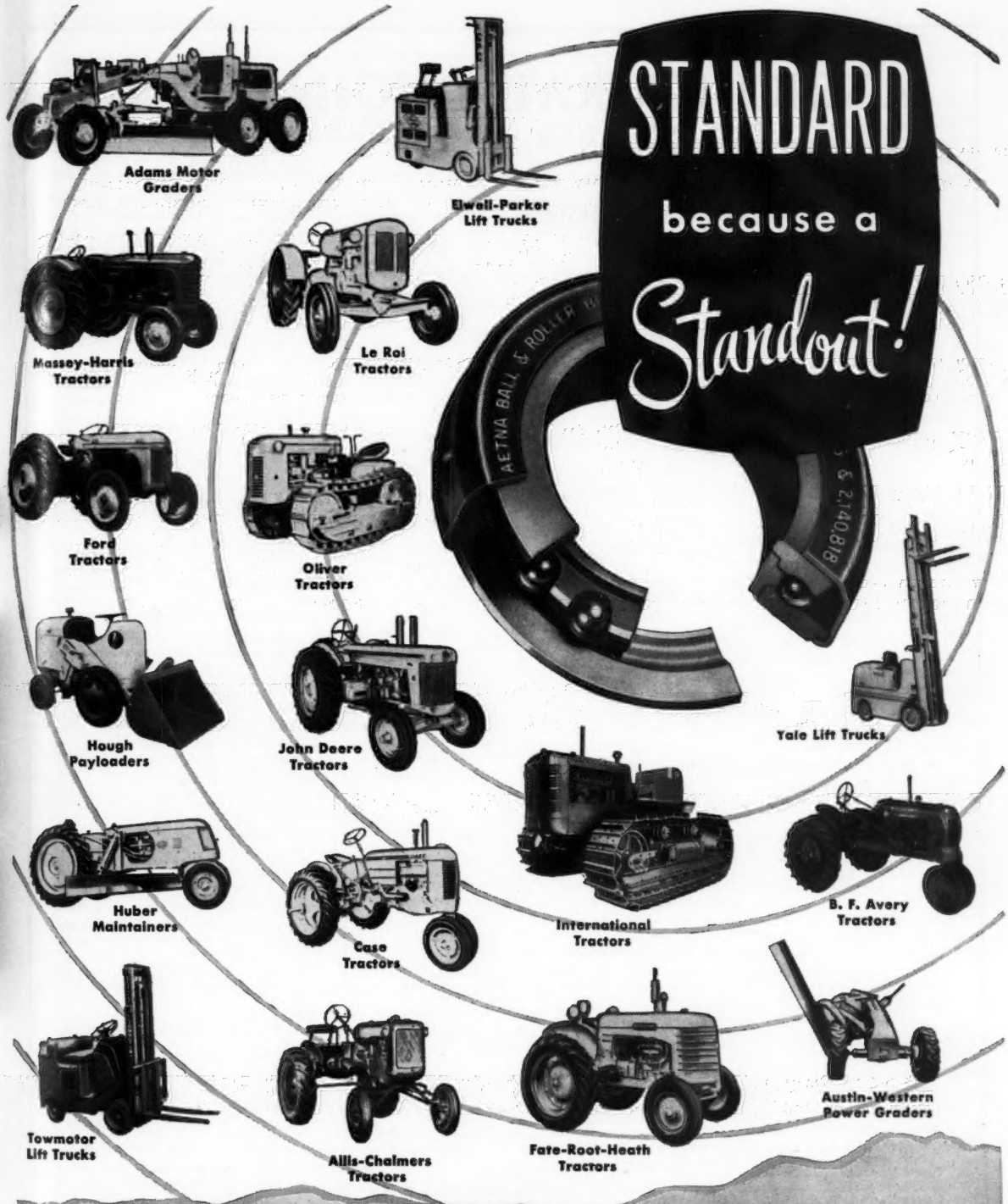

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EDITORIAL

Engineers' Position on Collective Bargaining

TWO principles were recently stated by the board of directors of the National Society of Professional Engineers, as a guide to engineers who may find themselves under pressure to join some collective bargaining organization. They are:

1 It is definitely unprofessional for a professional engineer, professionally employed, voluntarily to join a heterogeneous labor union dominated by, or obligated to, nonprofessional groups.

2 Organizations of professional engineers for collective bargaining in any form are to be deplored, although their existence, for the present, may be condoned under certain circumstances.

This stand by a strong professional group may serve in some instances to reduce pressure upon engineers to join bargaining agencies. It may also in certain cases give an individual engineer backing to justify a decision to stay clear of membership in a bargaining agency.

It might have been stated as a third principle that the interests of all classes of workers will be best served by engineers continuing to compete for their rewards on the basis of professional merit and performance. Numerically they would add little to the mass strength of organized labor. Functionally, as free agents with strong incentives to professional progress on their own initiative and ability, they will continue to be a strong factor in making it physically and economically possible to further improve the working conditions and pay of labor.

There is a way in which the unions might use engineers much more effectively than as numbers on their membership rolls. They might employ professional engineers to their advantage to represent before ownership and management, on a factual basis, labor's interest in what may be physically possible and mutually profitable in the matter of increased incentives, aids to increased productivity, safety measures, improved working conditions, and security of opportunity by the creation of new products, more jobs, better jobs and better opportunity for effective work. That would give real meaning to the words "collective bargaining."

Engineers may be expected to be among the first to recognize and welcome any progress toward more exact evaluation of the respective contributions of the various factors in production, and any improvement in pay and working conditions which that might make possible.

Until that day, the whole professional training and experience background of engineers suggests that more value for all can be realized by collective teamwork in production than by bickering over theoretical rights in values which do not yet exist and which cannot be produced effectively while the bickering continues.

Automation

AUTOMATION is a word coined rather recently by tool engineers to apply to the automatic handling of parts in production without physical effort by the operator.

It should have a definite place, we believe, in the thinking of agricultural engineers. It pictures an ideal in the conservation of human time and energy by engineering. It is as applicable to some production routines in agriculture as it is to those in mass production manufacture and processing.

Automation suggests the kind of thinking that has led us from the grain cradle and flail to the combine; which has given us seed and fertilizer drills, mechanical diggers, forage harvesters, automatic feed grinders, overhead feed bins and elevators, self-feeders, milking machines and a variety of other equipment which enables farmers to handle routine jobs better, faster, under more nearly optimum conditions, and with less labor than formerly.

Thinking in terms of automation will not give us an overnight revolution to push-button farming. It should help us to remember that one of the most important resources to be developed and conserved is human time. Automation means thinking toward higher levels of living by reducing the proportion of their lives which farmers and other workers alike must devote to the routine of producing their primary necessities.

Engineers and International Understanding

A RECENT discussion by a prominent engineer on how engineers can promote international understanding, sums the matter up rather neatly.*

Language differences, isolationism, and economic inequalities are continuing major barriers to mutual understanding. In contrast the international character of technology is a strong influence toward understanding between at least some of the peoples of different nations. It is an influence which might be further strengthened.

Several suggestions are given as to direct steps which engineering societies in the United States might take to make their technology more readily available to the engineers of other nations. Several of these involve financing beyond the present available means of the American Society of Agricultural Engineers. It is interesting to note, however, that two of the suggestions cover practices already of long standing in the ASAE.

The Society has consistently made AGRICULTURAL ENGINEERING and its other publications available to libraries and other depositories outside of the United States, at substantially cost price. It has also welcomed into its membership properly qualified citizens of other countries.

A continuing increase in members and non-member subscribers of Agricultural Engineers outside of the United States attests to their appreciation and to the effectiveness of these measures. The number of ASAE members in other countries is 292, and the number of such non-member subscriptions to our Journal about 680.

This is particularly appropriate in that, in many agricultural areas, agricultural engineering is definitely one of the several fields in which parallel progress is necessary to improvement of existing economic and social conditions.

*"How Engineers Can Promote International Understanding," by Robert M. Gates, representative of the Engineers Joint Council on the U.S. National Commission for UNESCO, in *Mechanical Engineering*, September, 1950.

Good Products

AN IMPORTANT advertising executive recently clarified his interest in agricultural engineers and their activities in these words: "A good product must be built before it can become a sales success." He is interested in what agricultural engineers are doing and can do to improve products.

One way of picturing the objectives and values of the service rendered by agricultural engineers is in terms of their contribution to the development and output of good products which can become sales successes.

Agricultural engineering is applicable to the improvement of a wide variety of products. It is most obviously an important means of improving farm operating equipment. It is the name applied to organized knowledge of the physical nature and proportions of the jobs to be done in and by agriculture, and of the materials, mechanisms, principles, and processes which can be applied to doing those jobs effectively.

It is a means of improving housing and home utilities for farm use, particularly in those cases where the dispersion of farm housing and other use conditions involve problems and products considerably different from those adapted to service in urban concentrations. *(Continued on page 524)*

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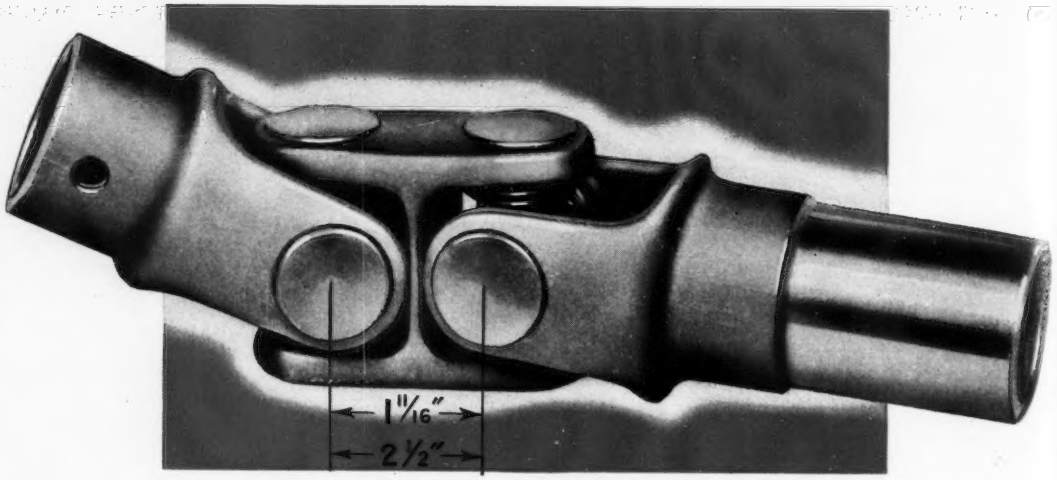

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AGRICULTURAL ENGINEERING

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Methods of Conditioning Shelled Corn

By George H. Foster
MEMBER A.S.A.E.

DRYING methods which could be employed to condition the shelled corn stored at bin sites of the Commodity Credit Corporation were tested and demonstrated during the winter and spring, 1950, by engineers engaged in crop-drying investigations. The program, sponsored by the Production and Marketing Administration, U.S. Department of Agriculture, was carried out at the Chalmers bin site in White County, Indiana.

Moisture limits for storage of grain in farm-type bins for periods of one year or more have been established through research and experience. The median moisture limit* established for the storage of shelled corn without loss of grade is 13 per cent, wet basis, as reported in USDA Farmers' Bulletin No. 2009.

A large part of the 1948 corn crop produced in Ohio, Indiana, Illinois, and Missouri, and delivered to the Commodity Credit Corporation under the price support program in the fall of 1949, was at moisture levels above 13 per cent. This condition was a result of unusually high atmospheric humidity conditions in this area during the late summer and early fall while the corn was still stored in the ear in farm cribs.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Washington, D.C., June, 1950, as a contribution of the Farm Structures Division. (It is also approved by the Director as Journal Paper No. 480 of the Purdue University Agricultural Experiment Station.)

The author: GEORGE H. FOSTER, associate agricultural engineer, division of farm buildings and rural housing (BPISAE), U.S. Department of Agriculture.

AUTHOR'S NOTE: The research work on which this paper is based was sponsored by the Production and Marketing Administration, USDA, and was carried out jointly by that organization, the Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, and the Purdue University Agricultural Experiment Station. The BPISAE portion of the study was made under the Research and Marketing Act of 1946, supplemented by CCC funds. The author is indebted to several representatives of these organizations, and particularly to H. J. Barre, Purdue University, for assistance and guidance in outlining and executing the project and reporting the results obtained.

*Median moisture limit applies to storage under climatic conditions midway between the best and worst for the particular grain-producing area.

The drying program described here was outlined to meet a possible emergency situation. The material presented in this paper describes the methods selected in view of the situation as it then existed, and does not necessarily imply that the methods employed are the best that are applicable where advance planning for conditioning can be accomplished. These tests demonstrated that drying can be successfully accomplished under such conditions by several methods. The best method or methods for this application will be determined through further research and experience.

At the Chalmers, Ind., bin site, CCC-owned corn was stored in structures of two general types. One was the farm-type metal or wood storage bin of from 2000-5000-bu capacity. The other type has been termed "flat storage" and has a storage capacity of about 25,000 bu. No provisions had been made to equip any of the bins for ventilation of the grain.

Consideration was given to a number of possible methods of conditioning grain. The criteria used for selection of methods to be investigated were (a) drying capacity, (b) drying cost, (c) handling cost, (d) equipment, and (e) control of the amount of moisture removed.

Drying Capacity. The capacity of a drying system is affected by both the amount of corn dried per hour and the number of hours of operation per day. There were several objections to 24-hr operation of driers that involved continual or intermittent handling of the grain, under the conditions of operation at the bin site. A drying system of only moderate capacity that could be operated 24 hr per day compared favorably with those of higher hourly capacity, but operated only during the daylight hours.

Drying and Handling Cost. It was readily apparent that the actual drying operation cost for reducing the moisture content 2 to 3 per cent was small as compared to the cost of moving the corn to a location where it could be dried. Any method which involved trucking to and from a drier required four handlings of the grain (loading and unloading), and the expense involved prompted selection of methods which held the amount of trucking to a minimum.

Equipment Investment. Consideration was given, first, to the original cost of the equipment, and, second, to its probable resale value. The government grain storage program is at

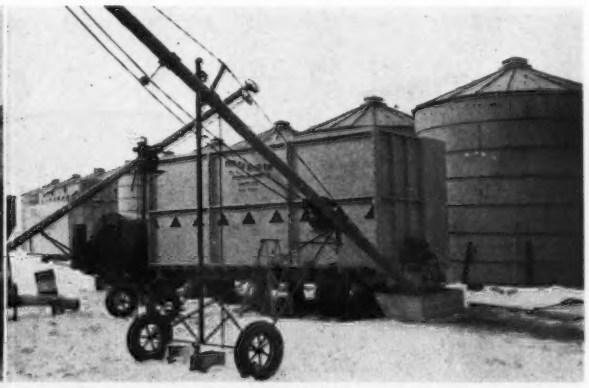


Fig. 1 *(Left)* The pneumatic grain-handling equipment used to transfer grain from the top of one bin to a nearby bin equipped for drying • Fig. 2 *(Right)* The 600-bu portable batch-type drying bin with the elevating equipment used for filling and emptying

present on a temporary basis. Moreover, an every year occurrence of wet grain was not expected in any one location. For these reasons, investment in permanent equipment involving a high initial cost was not considered desirable.

Control of Moisture Removal. It is necessary to control closely the final moisture content to which the grain is dried in order to provide safe moisture levels for storage without overdrying. The loss from overdrying becomes important in grain to be marketed. For example, for each per cent the moisture level is lowered beyond the safe storage limit, the loss in weight is nearly equal to 1 bu for every 100 bu dried.

DRYING METHODS AND EQUIPMENT

In view of the above, the application of portable farm-sized crop driers (forced-air heaters) to the drying of shelled corn in the CCC storages was undertaken. Driers of the type used are illustrated in Figs. 3, 5, and 6.

The methods selected for applying portable driers to the drying of shelled corn in each of the two types of storage buildings were as follows:

1 Farm-type bins (2200-3300 bu circular metal): (a) drying in storage bins equipped with perforated floors, and (b) drying in specially constructed movable batch-type drying bins.

2 Flat-type storages (25,000-bu quonset buildings), drying in the storage building equipped with duct system.

A perforated floor was used in the circular steel bins. The type of drier illustrated in Fig. 3 was attached to these bins. One of the methods used to transfer the corn from the nearby storage to an empty bin equipped with a perforated floor is shown in Fig. 1. Lots of shelled corn ranging from 600 to 2200 bu were dried at a time. The effectiveness of alternating periods of heated and natural air ventilation was tested.

Two types of portable batch-type drying bins were used with the portable driers. One type (Fig. 2) was developed and built by a commercial concern located in Indiana. The unit held approximately 600 bu. The drying air was distributed through the corn by a system of inverted troughs. A second type developed for these tests is illustrated in Fig. 3. Two columns of grain each 2 ft thick were separated about 3 ft to form a plenum chamber. The capacity per batch was 330 bu. A bin was provided on top to hold an additional 300 bu and was equipped with slides to drop the grain into the drying columns. In this way the only drying time lost was that required to empty the bin.

Both portable batch-type drying bins were equipped with augers for unloading. Portable auger elevators were used as shown in Fig. 2 to transfer the grain from the storage bin to the drying bin and then back to an adjacent empty storage bin. Thus with one empty bin at the end of a row of bins, drying could proceed, without trucking, by moving the portable bin along the bin row.

Drying of shelled corn in the flat storages was accomplished by the installation of duct systems. Two types of ducts were tried. One required an empty storage for installation, Fig. 4. The corn was then transferred directly from an adjacent building with auger elevators. A second type consisted of perforated tubes which were forced into the corn through the sides of the building. This method eliminated moving the corn.

A portable drier was attached at each end of the central duct system and Fig. 5 shows a drier attached at the front end. One half of the corn in the storage bin equipped with the perforated pipes was dried at a time. The drying fan was connected to the perforated pipes by a manifold-type canvas duct, Fig. 6.

RESULTS

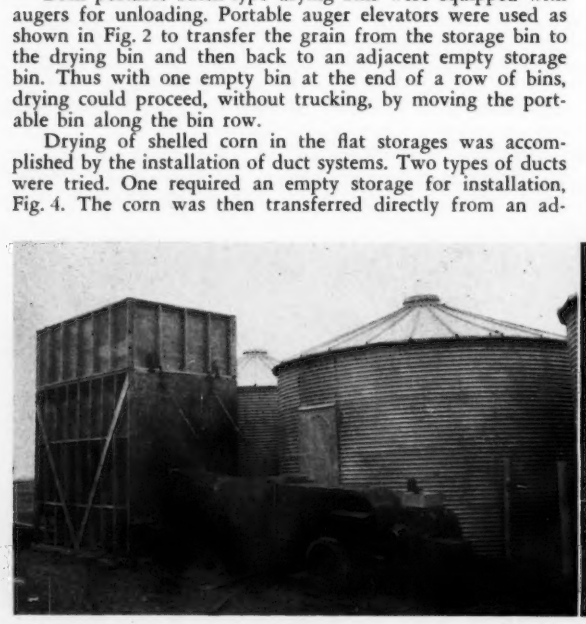
Considerable demonstration activity in connection with drying 70,000 bu of shelled corn was included along with the

TABLE 1 SUMMARY OF SERIES B DRYING TESTS IN 8-FT-DIAMETER STORAGE BINS EQUIPPED WITH PERFORATED FLOORS

		B1	B2	B3	B4	B5	B6
1	Test No.						
2	Date started	2-1-50	2-3-50	2-20-50	2-24-50	2-23-50	2-7-50
	Date completed	2-20-50	2-20-50	2-21-50	2-25-50	3-15-50	2-7-50
3	Number bushels	1,700	1,600	1,000	1,200	2,000	600
4	Depth of grain, ft	8½	8	5	6	10	5
5	Initial moisture, % w.b.	14.8	14.4	14.5	15.0	14.4	15.3
6	Final moisture, avg % w.b.	13.7	12.9	13.0	13.5	13.2	13.5
	Bottom ⅓	13.5	11.3	12.3	12.9	11.8	—
	Middle ⅓	13.5	13.6	13.0	13.5	13.5	—
	Top ⅓	14.2	13.8	13.7	14.0	14.3	—
	Top surface	14.7	14.6	13.9	14.7	14.4	—
7	Water removed, lb.	1,000	1,550	970	1,150	1,600	700
8	Estimated air flow, cfm						
	Total	6,250	7,000	8,700	9,000	5,700	11,000
	Per bushel	3.7	4.4	8.7	7.5	2.8	18.4
9	Drier operation, hr						
	With heat	61	16	10	10½	20	2
	Without heat	12	17	10	9	68	1+
10	Fuel used, gal						
	Heater—No. 1 fuel oil	48	50	40	42	81	18
	Engine—gasoline	75	42	20	21	95	4+
11	Avg temperatures, deg F						
	Atmosphere	36	37	36	8	25	34
	Heated air*	54	94	96	74	100	140
	Dew point	30	30	29	2	20	—
12	Drying cost, cents†						
	Per bushel	1.3	1.0	1.0	0.9	1.6	0.6
	Per pound water removed	2.2	1.0	1.0	0.9	2.0	0.5

†Cost for fuel oil (14c per gallon) and gasoline (21c per gallon) only.

*From 3 to 5 F temperature rise was obtained from the waste heat of the fan engine in all tests except B6.



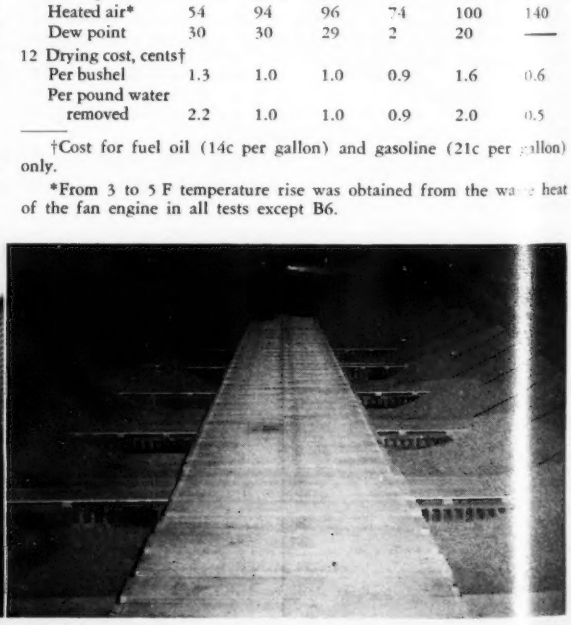


Fig. 3 *(Left)* The column-type batch-drying bin with portable drier in operation • Fig. 4 *(Right)* Duct system with concrete block laterals used in test F3

investigations reported herein. The time schedule required to meet the demonstration dates often precluded the collection of complete research data with the limited personnel available. This, together with the variable weather conditions encountered during the winter and early spring, accounts for some of the apparent discrepancies of the data from similar tests. However, the relatively large amount of corn dried by each of the three methods lends reliability to the comparisons between methods if not between individual tests.

Drying in Storage Bins with Perforated Floors. The general summary of the drying data collected in tests utilizing perforated floors in storage bins appears in Table 1. Different temperatures of the heated air together with various amounts of corn are represented in the tests. Also, alternate periods of ventilation with heated and natural air were used in an effort to reduce the moisture differential between the bottom and top of the grain. The schedule was as follows:

Test B1—continuous heated-air drying with a limited temperature rise

Test B2—4 hr heat, 4 hr natural air, alternately

Test B3—5 hr heat, 5 hr natural air, alternately

Test B4—10 hr heat, followed by 10 hr natural air

Test B5—10 hr heat, 10 hr natural air, alternately

Test B6—high heat input with limited depth of grain.

In test B1, an effort was made to operate a drier rated at 4 gal of oil per hour at a reduced rate of one gallon per hour. The burner did not operate satisfactorily at a fuel rate of one-fourth its rated capacity. The length of time required to reduce the moisture by only one per cent was considered excessive. With the reduced temperature rise, the cost for fuel for the engine-driven fan was greater than the oil used to heat the air.

The use of alternate periods of heated and natural-air ventilation provided improved operating conditions during the heating period since the driers were run at rated oil capacity while the burner was on. However, the moisture differential between the grain in the top and bottom of the bin was not reduced sufficiently by this method when more than 1200 bu were dried at one time.

When the amount of corn dried at one time was limited to about 1000 bu, satisfactory drying was accomplished. This amount could be dried in one day by supplying heat during daylight hours only, and cooling with natural-air ventilation at night. The drying capacity per 24-hr day per drier compared favorably with that of the drier used with the specially constructed drying bin which was operated only during daylight hours. However, drying the smaller batches required either extra handling of the grain or filling the bins to less than the full capacity.

Drying in Specially Constructed Portable Drying Bins. The portable drying bins overcome two of the difficulties encountered in connection with drying in storage bins. First, full capacity of the heating units could be utilized since the depth of corn through which the air passed was reduced. Secondly, the grain was mixed after drying as the grain was returned to the storage bin. This effectively eliminated the moisture differential problem encountered in the storage bin drying tests.

The results of fourteen tests in two types of portable drying bins are given in Table 2. Four of the tests were made in the larger bin and ten in the smaller one.

The drier used with the larger bin had an oil capacity of 8 to 10 gal per hour. This larger drier was also used with the smaller bin in tests P10 and 11. For the other tests in the smaller bin, a drier rated at 4 gal of oil per hour was used.

The moisture content of the corn was reduced about 1.4 per cent average for all tests. This was accomplished by supplying 3.1 gal of fuel for each 100 bu dried. Slightly less drying was accomplished than planned since the final average moisture was about 13.3 per cent, wet basis, in place of the desired 13 per cent. Most of the tests were conducted at an ambient temperature under 40 F and some during rainy and snowy weather. In general, more moisture was removed per gallon of fuel supplied when the outdoor temperature was higher.

The effect of using a higher temperature rise can be noted in the results of these tests. For example, in tests P10 and 11 a temperature rise of nearly 100 F was maintained in the drying air with the higher capacity drying unit. The moisture content of 330 bu of corn was lowered from 1.5 to 2.0 per cent with 11 gal of fuel. In tests P6, 7, 8, and 9, and using the drier at 3½ gal of fuel per hour to maintain a temperature rise of about 45 F, the moisture content was lowered from 1 to 1.5 per cent with the same amount of fuel.

Drying in Flat Storage Buildings Equipped with Duct System. The corn in three quonset storage buildings of 25,000-bu capacity was dried. Either two portable driers were connected to each building and operated simultaneously, or one drier was used to dry one-half of the building and then later attached to the other half. Tests F1 and 2 in Table 3 were made on the corn in the same building. Different duct systems were used in each end. Also, the schedule of drier operation was different for each end. Test F4 includes the drying in only one-half of the building and the building was divided length-

TABLE 2 SUMMARY OF SERIES P DRYING TESTS IN PORTABLE DRYING BINS

1	Test no.	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14
2	Date	2-3	2-6	2-23	2-24	2-7	2-9	2-10	2-15	2-16	2-17	2-22	2-24	4-13	4-19
3	Number bushels	600	600	600	600	330	330	330	330	330	330	330	330	330	330
4	Initial avg moisture, % w.b.	15.0	14.8	14.6	14.6	14.9	14.5	14.6	14.4	14.4	14.4	14.8	15.2	14.7	14.8
5	Final avg moisture, % w.b.	13.3	13.5	13.5	13.3	13.8	13.8	12.9	13.4	13.4	12.4	13.3	14.2	13.1	12.5
6	Water removed, lb	700	500	450	520	260	180	390	230	230	440	340	240	370	490
7	Estimated airflow, cfm														
	Total (in thousands)	11	11	11	11	10.5	10.5	10.5	10.5	10.5	10.2	10.0	10.5	10.5	10.5
	Per bushel	18.3	18.3	18.3	18.3	31.8	31.8	31.8	31.8	31.8	31.8	31.0	31.0	31.8	31.8
8	Drier operation, hr														
	With heat	2	2	2½	2	2	3	3	3	3	1½	1½	3	3¾	3¼
	Without heat	1½	1⅔	1	1	1½	1	1	1	1	1	1	2	1¾	1
9	Drier fuel rate, gph	8	8	8	10	3½	3½	3½	3½	3½	8	8	3	4	4
10	Fuel Used, gal														
	Heater, No. 1 fuel oil	16	16	20	20	7	11	11	11	11	11	11	9	14	12
	Engine, gasoline	4+	4+	5	4	7	8	8	8	8	4	4	8	7	5+
11	Avg temperature, deg F														
	Atmosphere	36	41	32	10	36	38	46	30	29	36	20	14	34	54
	Heated air*	128	130	120	133	82	80	90	74	73	125	115	58	85	108
12	Drying cost, cents†														
	Per bushel	0.5	0.5	0.6	0.6	0.7	0.9	0.9	0.9	0.9	0.7	0.7	0.9	1.0	0.8
	Per pound water removed	0.4	0.6	0.9	0.7	0.9	1.8	0.8	1.4	1.4	0.5	0.7	1.2	0.9	0.6

*Approximately 3 F temperature rise was obtained from the waste heat of the fan engine in tests P5, 6, 7, 8, 9, 12, 13, and 14.

†Cost for fuel oil (14c per gal) and gasoline (21c per gal) only.

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wise instead of across the short dimension. The drier used in tests F1, 2, and 3 was of the heat exchanger type and had a maximum fuel rate of 6 gal of oil per hour. In test F4, an engine-driven 36-in propeller fan was used. The engine was shrouded in such a way that the waste engine heat was drawn into the drying air stream.

The schedule of drier operation in each of the tests was as follows:

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1	Test No.	F1	F2	F3	F4
2	Date started	2-15-50	2-16-50	5-1-50	5-1-50
	Date completed	3-11-50	3-14-50	5-6-50	5-11-50
3	Number bushels*	11,000	11,000	22,000	12,000
4	Type of duct systems†	A	B	C	D
5	Initial moisture, % w.b.	14.7	14.4	14.7	14.3
6	Final avg moisture, % w.b.	13.0	13.0	13.2	13.2
7	Water removed, lb	12,000	10,000	21,000	9,000
8	Estimated airflow, cfm			(two driers)	
	Total	12,000	12,000	25,000	9,200
	Per bushel	1.1	1.1	1.2	0.8
9	Drier operation, hr				Engine
	With heat	164	235	60	Heat Only
	Without heat	162	67	43	178
10	Fuel used, gal‡				
	Heater, No. 1 fuel oil	654	586	600	——
	Engine, gasoline	336	298	232	305
11	Temperature, deg avg				
	Atmosphere	31	31	64	65
	Heated air	65	50	103	79
	Dew point	24	24	51	52
12	Drying cost—cents‡				
	Per bushel	1.5	1.3	0.6	0.5
	Per pound water removed	1.4	1.4	0.6	0.7

*Only one-half of the corn stored in a 32x96 ft quonset building was included in tests F1, 2, and 4.

†Dimensions and spacing of duct systems used: Type A. Central duct 2 ft high x 4 ft wide inside, length of building with laterals 6 ft long spaced 8 ft o.c.; area under inverted trough laterals 50 sq in. Type B. Central duct same as Type A, with same laterals except 9 ft long and spaced 4 ft o.c. Type C. Central duct same as Type A, with concrete block laterals 8 ft long and spaced 8 ft o.c.; area under laterals, 110 sq in. Type D. Perforated tubes 10 in in diameter spaced 8 ft o.c. and extending 12 ft in toward center from side of building.

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Agricultural engineers subscribe to the credo of all engineers: "The difficult is accomplished immediately; the impossible takes a little longer." However, to live up to that creed, research must be used to find many answers. In attempting to develop a new machine, the first engineering requirement is the development of a satisfactory set of functional specifications. *What must the implement do?* To answer this question calls for applied research of the broadest nature. Past experiences must be reviewed. Why did the previous process or processes fail? What are the good points? Have conditions changed in any way? Do any new developments now help to simplify the requirement? The search must be thorough. It may be necessary to experiment with previous units to fill in the gaps and find the answers to all the questions. Invariably the answers can be found if the engineer uses experimental research in conjunction with a thorough study of all available literature, discusses the problem with qualified personnel, and makes good use of his imagination and inquisitiveness.

Somewhere in the research covering a new machine another question must be answered, namely, "What is the market for this machine?" That question is not restricted to commercial organizations. An experiment station director is unlikely to approve a project without a "market" for the hoped for end result. Market research, as it is called, is not a simple matter of asking prospective buyers if they will cease being "prospective" when the wonderful machine arrives. How can they tell what they may buy when they have not seen the future mechanical gem, and do not know how it functions? Market research goes far deeper, exploring the economic and the agronomic phases of the problem in an endeavor to project the real possibilities of the proposed machine. Market research has killed more engineering brain children than any other malady. Nevertheless it is research that the wise engineer uses to the fullest to insure the value of his productiveness.

Having established the functional requirements that must be met, and finding that a satisfactory market exists for a machine that economically performs the prescribed functions, the engineer is confronted with the problem of developing a machine to do the job. *How do you do it?*

This kind of research is some of the most intriguing conducted anywhere. The objective is to perform the function outlined in the specifications, already developed, with as simple and as efficient a unit as possible. To do this requires a most vivid imagination, along with a wide general knowledge of processes, materials, mechanics, electricity, light, heat, chemistry, physics, plus anything else that the engineer happens to know. It can be seen that not every engineer would qualify for this kind of work. Nonetheless any engineer with plenty of imagination and curiosity can be an outstanding development man through careful planning, hard work, and straight thinking.

The one characteristic that a development man must have in abundance is perserverance. While finding out "how do you do it" the engineer must expect many discouragements, as he will see more than one brilliant idea (at least so it appears) collapse from its own weight. It may be a rough and long road, but the reward is sure for those that refuse to be beaten.

For the sake of this paper, let it be assumed that the development man's researches have answered a sufficient number of new questions to permit him to fabricate and test a unit that meets the functional requirements. If this unit appears to have commercial possibilities—that is, if it is simple to build, to operate, and to maintain; if its estimated cost is reasonable, and if it has possible sales appeal—the next step is to design a good mechanical unit along the lines of the development man's experimental machine.

When mechanical design is undertaken, an entirely new group of questions arise to confront the designing engineer. What forces are involved? What are the time and motion factors? How severe are the acceleration and deceleration forces? Can the weight be reduced? Is the balance satisfactory? Are the vibrations within acceptable limits? These questions and many more must be asked and answers determined by engineering design and applied research to enable the engineer to produce a unit that is proportionately designed. Or to express it differently, uniformly stressed to provide necessary life with the least material, and the minimum of mechanical failure during its expected life—"the one-hoss shay" in modern version, if you please.

In this stage of development, research by experimental stress analysis in its various ramifications produces large dividends. Ingenuity in applying and using all known testing techniques is of real value to the implement engineer. Not many determinations are routine. The installation must be studied carefully and the best combination of tools used. Usually the majority of the test rigging must be "cobbled up" without spending large sums of money. This industry cannot justify the elaborate and expensive laboratories so common to high-volume, single-product industries. Good, useful, standard instruments are available, but without engineering application they are merely pretty, although expensive, objects in the experimental engineering department.

By one means or another this new implement we are discussing has now been designed and placed in production. Is the research in connection with this machine ended? Most definitely it is not! The problems may be of a different nature, but there are just as many of them to solve as at any previous time. Research likewise solves many of these problems.

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2 Providing satisfactory life for all parts by better stress distribution, by reducing shock loading through the introduction of rubber or other resilient material, by developing better manufacturing procedures for more uniform quality, and by other means

3 Developing the use of new and improved materials to increase strength, fatigue life, or wear, to reduce costs through material or labor savings, and to conserve metals, elements, labor, or facilities that may be essential to our national well being

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operator. The machine should be "foolproof". Safety is directly related to the operator. Much research is required to protect the operator from himself, and today this is a most active phase of research in the farm machinery industry.

This short resume of problems present in production implements must remove any doubts in anyone's mind as to the need for research in the current design level of activity. Although different in detail, research is just as important during production as it is in the conception and development phase.

A careful review of the many fields of engineering activity reveals none with more romance, intrigue, variation, ramification, nor complication than shown in the design research of farm machinery. The engineering of farm machinery embraces applied research so completely, simply because there is a great shortage of facts in, and established means of correlating known engineering truths to the science of agricultural engineering.

This combination presents the design of farm machines as an outstanding challenge to the engineer. Nothing attracts engineers like a challenge to their abilities. Yet we are confronted with an industry shortage of qualified designers. The only explanation for this shortage is that the young engineers have not been told of the possibilities and advantages in the direction of their professional development in the design of farm machinery. Therefore most qualified men have taken up other phases of engineering design.

Let all of us resolve to tell the story of the wide-open field of opportunity for engineers in research and design of modern farm machinery. There is no better place for the engineer to satisfy his curiosity and exercise his ingenuity than in farm machinery research.

Research is the foundation on which the farm machines of the second half of the twentieth century will be built.

Conditioning Shelled Corn

(Continued from page 500)

have the same area as that of the cross section of grain through which the drying air passes. Under these conditions, from 7 to 10 per cent of free opening is sufficient for the passage of the volume of air ordinarily used in drying. In applying these data to duct systems the following must be considered if high pressure losses due to concentration of airflow at the duct outlets are to be avoided:

(a) Total area of duct surface

(b) Total area of air openings in duct surface

(c) The distribution of openings over the duct surface.

A full analysis of this problem cannot be included in this paper. However, observations on pressure and moisture gradients through the corn have been observed on the duct systems used in these tests.

Figs. 7 and 8 illustrate the difference in final moisture distribution when the temperature rise of the drying air is increased. Fig. 8 represents the final moisture observed in "flat-storage" test F3. The corn next to the duct was reduced to a moisture content below 9 per cent. A much higher percentage of the corn near the surface is at a higher moisture level in test F3 than that dried with a lower temperature in test F1 and which is illustrated in Fig. 7. Reasonable consistency was experienced between the pressure measurements taken during drying and the final moisture distribution within the corn.

Perforated metal tubes 10 in in diameter and 12 ft long were inserted through the side of the quonset storage every 8 ft in test F4. Considerable work was involved in developing methods to insert the tubes. Measurements taken indicate that a force of 3000 lb plus 550 lb per ft of length in contact with the corn was required to force the tubes into the corn 8 to 10 ft below the surface. This method has one chief advantage in that the duct system can be installed after the storage is filled. Several disadvantages were apparent in this installation such as damage to the building and heat loss from the long exposed canvas connection from the drier to the tubes. The test results indicated that more tubes or larger size tubes were needed for drying at more rapid rates with heated air.

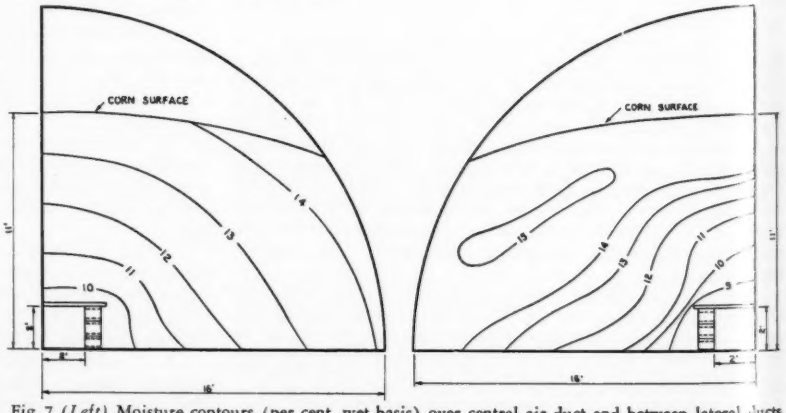

Fig. 7 *(Left)* Moisture contours (per cent, wet basis) over central air duct and between lateral ducts in test F1 • Fig. 8 *(Right)* Moisture contours (per cent, wet basis) over central air duct and between lateral ducts in test F3

SUMMARY

1 Grain stored with a moisture level from 1 to 3 per cent above the safe storage limit can be dried satisfactorily at CCC-storage sites with farm-size portable crop driers.

2 Drying in portable drying bins provided the most practical method of using present crop driers to condition the corn stored in the farm-type storage bins. Drying in the storage buildings with duct systems for distributing the drying air appeared to be the most practical method of using portable driers to condition the corn stored in the flat-type storages.

3 The capacity of the farm-type driers under the conditions of these tests was about 1000 bu per day.

4 Approximately 2 gal of oil were required to reduce the moisture content of 100 bu of corn by one per cent under the test conditions described. Slightly more oil was required during cold, damp weather and less during warm, dry weather.

5 A temperature rise above the dew point of 40 F or more increased the speed of drying, but a means of mixing the corn after drying was required when high temperatures were used with normal rates of airflow.

6 Farm drier equipment is not yet developed sufficiently to give adequate service under continuous operating conditions, according to experiences in these tests. For continuous operation, the driers should be powered with electricity. If gasoline engines are used, provisions should be made to reduce the vibration to the point that controls will operate properly and fatigue failure of parts will be eliminated.

7 The cost of handling the grain in connection with the drying operation often exceeded the cost of drying. Handling equipment of the light-weight auger type appeared to be the most desirable for loading trucks from the bins and for transferring corn from one bin to the other. Six-inch augers, light enough in weight for one man to move, were capable of handling up to 25 bu of corn per minute. Pneumatic grain-moving equipment of the suction-intake pressure-discharge type was found most suitable for special jobs such as removal of corn from the top of a bin.

8 The installation of ventilating equipment in the storage prior to filling would eliminate most of the handling expense involved in these tests. Attention should be given to developing equipment suitable for use in conditioning corn stored at greater depths in the farm sized bins. This would eliminate the handling cost in connection with the use of portable drying bins.

Electric Lamps and Traps in Corn Borer Control

By John G. Taylor and Howard O. Deay

JUNIOR MEMBER A.S.A.E.

ESTIMATES of the damage to corn by the European corn borer during the summer of 1949, made by the U. S. Department of Agriculture, indicate that the total amount of corn lost to the borer exceeds 291 million bushels in Ohio, Indiana, Illinois, Iowa, Wisconsin, and Minnesota (1)*. This insect caused an estimated loss of nearly 314 million bushels of corn, worth approximately 350 million dollars, in the entire country in 1949. Therefore, this pest has become one of the most important single agricultural insect species in the United States. Development of methods which might lead to the control of the borer has been the object of cooperative research conducted by federal and state entomologists and agricultural engineers for a number of years.

Research on the use of radiant energy to control the European corn borer (*Pyrausta nubilalis Hbn.*) was started in Indiana in 1935 by T. E. Hienton, agricultural engineering department, and the late G. A. Ficht, entomology department, Purdue University (2). This control method is based on stopping the corn borer cycle at the moth stage. Each female moth attracted to a trap and killed before she lays her eggs means the destruction on the average of a potential 400 corn borers (3). In laboratory and field studies they found that corn borer moths were most attracted to sources radiating in the blue region of the electromagnetic spectrum and that enough moths were attracted to electrocuter traps to reduce materially the population of the larvae in irradiated fields of dent corn. This work was discontinued in 1943 because of the war.

The present project on corn borer control was inaugurated at the Purdue station in the spring of 1947. It is a cooperative project between the departments of agricultural engineering and entomology of the Purdue University Agricultural Experiment Station and the division of farm electrification, Bureau of Plant Industry, Soils and Agricultural Engineering, U.S. Department of Agriculture†.

The objectives of the project are (a) to determine the particular wave length, source and intensity of electric radiant energy most attractive to the European corn borer moth, (b) to study the types of traps using electric energy and their field spacing in relation to their effectiveness in capturing European corn borer moths, and (c) to determine the effectiveness and the practicability of using electric energy for the control of the European corn borer.

The studies in 1947 were confined to the determination of the relative attractiveness of different wave lengths of radiant energy; those in 1948 to studies of intensities and wave lengths; and those in 1949 to field studies of intensities, field spacing of traps, and tests on the reduction of borers in sweet corn by irradiating the fields. The following results have been obtained to date:

Wavelength Studies. Field studies on the type of radiation most attractive to the corn borer moth were undertaken on a 10-acre field of early-planted field corn located 2 miles south of Lafayette, Ind., during the summer of 1947. Five different radiant sources replicated twice were tested by comparing counts of moths made at each trap.

Lamp sources consisted of three 100-w CH-4 mercury-vapor lamps, an 8-w germicidal lamp and a 15-w green fluorescent lamp. Corning glass filters were used to isolate the particular radiation desired. Two sources were peaked in the ultraviolet region, one in the far ultraviolet at 2537 A (Angstrom units) and the other in the near ultraviolet region at 3654 A. A third source was a blue source peaking at 4357 A, a fourth source was green peaking at 5250 A, and the fifth source was a bluish-white source (the CH-4 mercury-vapor lamp) radiating through the principal mercury lines from 3131 A to 5780 A.

The lamps and filters were assembled in a plywood housing 48 in long by 12 in wide by 12 in high. A galvanized iron funnel 18 in long with a 12 in opening at the front tapering to a 3 in opening at the rear was placed in front of the 2x2-in filters. A smaller funnel mounted perpendicular to the underside of the main funnel tapered to a mason jar charged with calcium cyanide into which the moths attracted to the radiant source dropped (Fig. 1).

Each trap was supported by a 4x4-in post along the north edge of the corn field. They were adjusted in height to just above the top of the

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*Numbers in parentheses refer to the appended references.

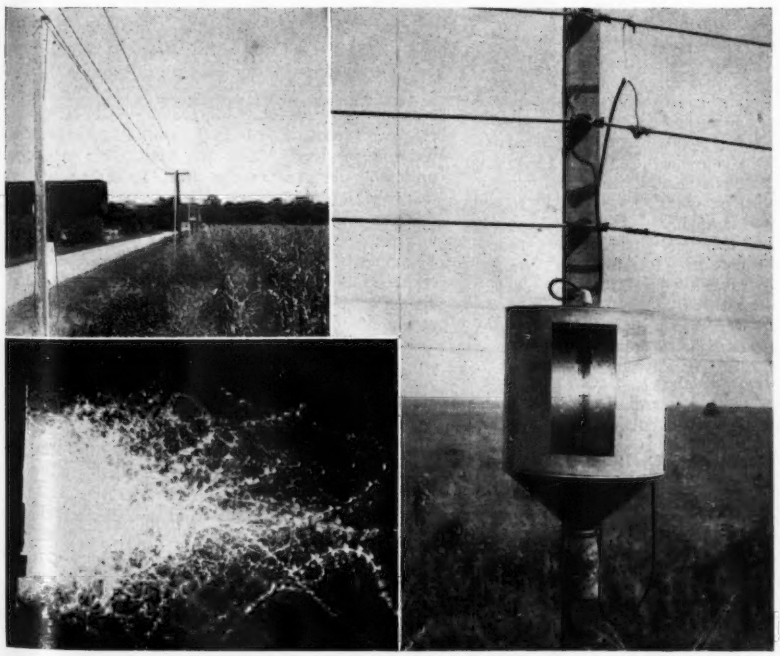

Fig. 1 *(Upper left)* Field installation of funnel traps used in wave length studies • Fig. 2 *(Lower left)* Time exposure of insects flying into trap • Fig. 3 *(Right)* Cylindrical-type trap shown here, and used in intensity experiments, is a 250-w mercury vapor lamp

†The Farm Electrification Division (USDA) also worked cooperatively with Iowa State College in setting up similar investigations.

corn. The ten traps were installed approximately 70 ft apart and were so constructed and installed that no overlapping of their radiant output occurred for a distance of 135 ft in front of the traps. The lamps were controlled by a time clock adjusted to turn them on in the evening at dusk and off at dawn. Catches were counted daily and the jars emptied and recharged.

The near ultraviolet source (3654 A) attracted 48.5 per cent of the total catch, the bluish-white (3131 to 5780 A), 17.6 per cent; blue (4357 A) and an ultraviolet (2537 A) each attracted 15.5 per cent and the green (5250 A) 2.9 per cent of the total.

Sixty-seven per cent of the total capture were females and were gravid through the peak of the oviposition period. Distribution of the field's moth population was evidently quite uniform although relatively light, and position of the traps showed little effect on the numbers captured. No accurate instruments were available for field intensity measurements and intensities may not have been equal.

In the spring of 1948 laboratory tests were conducted on the relative attractiveness of different types of fluorescent lamps to the corn borer moth. In these tests one or more fluorescent lamps were placed at each end of a 15-ft cylinder which was 24 in in diameter. Electrocuter grid panels were placed between the lamps and the cylinder. These panels killed the moths as they were attracted to the lamps. Moths were released at a center opening in groups of 10 to 20 and comparisons were made of the number of moths killed at each grid.

All comparisons were made with a 360 BL fluorescent lamp which produced ultraviolet radiation peaking at 3650 A. This lamp was selected as a standard as a result of the preference shown by the moths to this wave length in the previous field studies.

Table 1 shows the results of 27 tests using six different

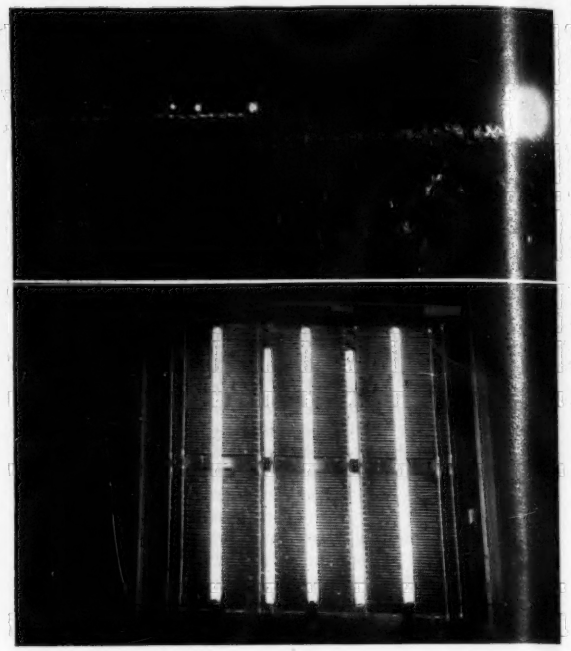

Fig. 4 (*Top*) Night view of 1949 first generation field test over sweet corn • Fig. 5 *(Bottom)* Grid trap with five 30-w, 360 BL lamps used in field tests in 1949. Similar traps were used in tests in Indiana and Iowa with the lamps mounted horizontally

TABLE 1. LABORATORY TESTS OF THE RELATIVE ATTRACTIVENESS OF VARIOUS GAESOUS DISCHARGE LAMPS TO THE EUROPEAN CORN BORER MOTH

Number of tests	No. 15-w 360 BL lamps used	Gaseous discharge lamps compared with the 360 BL type lamps			
		No. of lamps	Size and type	Peak wave length (Angstroms)	Per cent of total moths attracted
1	1	1	15-w germicidal	2537	0.0
1	1	2	15-w germicidal	2537	0.0
2	2	4	30-w germicidal	2537	23.0
4	2	6	30-w germicidal	2537	47.6
3	1	1	20-w E phosphor	3250	60.0
1	1	2	20-w E phosphor	3250	42.8
3	2	1	20-w E phosphor	3250	40.0
1	2	2	20-w E phosphor	3250	20.0
3	1	1	15-w blacklight	3650	34.7
3	1	1	15-w blue	4400	20.0
1	1	2	15-w blue	4400	16.6
1	1	1	15-w green	5300	20.0
1	1	2	15-w green	5300	25.0
1	1	1	15-w daylight	4400 to 6300	0.0
1	1	2	15-w daylight	4400 to 6300	0.0

sources. Germicidal (2537 A), E-phosphor (3250 A), black light (3650 A), blue (4400 A), green (5300 A) and daylight (4900 to 6300 A) were tested against the 360 BL lamp in different intensity combinations.

Of the various lamps tested the only lamp which attracted more moths than the 360 BL lamp was that of one 20-w E-phosphor which, when compared with one 15-w, 360 BL lamp, attracted 60 per cent of the moths. Two 15-w germicidal lamps, when compared with one 360 BL, attracted no moths; similarly two 15-w daylight lamps, when compared with one 15-w 360 BL lamp, caught none.

From these tests it appears that the maximum attractiveness for the European corn borer moth at the intensity levels studied is in the near ultraviolet region between 3200 and 3800 A.

Intensity Studies. Studies on intensity were begun in the laboratory in the spring of 1948 using the test cylinder procedure previously described.

In five tests made with the 360 BL lamp it was shown that two or three lamps were more attractive than a single lamp, but there was very little difference in attraction between two lamps and three lamps.

Field studies of intensity were made in the summer of 1948 using the funnel-type traps used the previous year in the wave length studies. In replicated tests run from June 9 to July 8 over field corn with ultraviolet sources at 3650 A having relative intensities of 1, 2, and 7.5, the catches were, respectively, 12.2 per cent, 28.1 per cent, and 59.7 per cent of the total. In tests with two traps which ran from June 9 to July 8 with sources radiating the complete ultraviolet and visible mercury-vapor spectrum (3131 to 5780 A) at relative intensities of 1 and 3, the catches were, respectively, 40 and 60 per cent of the total. These tests indicated that higher intensity sources attracted more moths but not in direct proportion to intensity. A time exposure of insects flying into one of these traps is shown in Fig. 2.

A check was made on the reduction of infestation in relation to intensities of the sources radiating energy at 3650 A. A count was made of first generation corn borer infestation in hybrid dent corn and population in stalks irradiated by the lamps within a radius of 70 ft from the lamps and compared with a similar adjoining area not irradiated. A 33 to 64 per cent reduction of borers was found in the irradiated areas as compared with the non-irradiated areas. This reduction was in direct proportion to the number of moths caught in the different traps.

Further intensity studies were made in the summer of 1949 over early planted dent corn. A cylindrical type trap was constructed, 16 in in diameter and 16 in high, with a funnel at the bottom which supported a Mason jar charged with cyanide (Fig. 3). A 6x12-in opening at the front was cut from the cylinder to emit the light and to permit the

Special trap designs tested using modified arrangements of grid panels. Fig. 6 *(Top)* A rectangle formed by 4 panels • Fig. 7 *(Center)* An inverted Y formed by 3 panels with the two lower panels set at an angle of 135 deg from the vertical • Fig. 8 *(Bottom)* A modified Y in the horizontal plane formed by 3 panels 120 deg apart

moths to enter. A high percentage of the moths dropped into the Mason jar where they were killed by cyanide gas, permitting counts to be made.

Six traps arranged at random in two series were supported vertically on poles at a level just above the corn and spaced at intervals of 80 ft. Lamps were all of the high-intensity mercury-vapor type of 250-, 400-, and 1000-w sizes. From June 3 to June 24 these traps caught a total of 1842 moths, 67 per cent of which were females. The 250-w traps caught 32.5 per cent, 400-w 19.5 per cent, and the 1000-w 48.0 per cent of the total. No explanation is known for the small catches made by the 400-w traps. It is doubtful that it was entirely due to field position. On a basis of the number of moths caught per lamp-watts, the 250-w lamp was the best. It is interesting to note that on the second night of operation, June 4, when according to the usual method of making moth emergence studies by inspecting representative samples of corn borer pupae no moths had been found to emerge, 72 moths were caught by one 1000-w trap.

Although no control of field infestation was attempted by this experiment, population counts of first generation borer infestation were made for the first 28 rows from the lights. In the lighted portion of the field the population was 9 borers per 100 stalks, representing a reduction of 92 per cent over the unlighted portion of the field where the population was 115 borers per 100 stalks.

An extremely high-intensity mercury-vapor lamp borrowed from the General Electric Company was used in exploratory studies in 1948. This lamp, designated the H-6, was water-cooled and had a rating of 1000 w and radiated from an arc tube only one inch in length.

When operated in the darkened laboratory with moths liberated in the room, no moths were observed to fly into the source, which was operated both with and without an ultraviolet filter.

TESTS TO DETERMINE SWEET CORN PROTECTION

Several field tests were made but few night-flying insects came to the lamp, although some were attracted to within 15 or 20 ft of the lamp. Many day-flying insects did come directly to the lamp, however.

Field Tests. First field tests to determine if sweet corn could be protected with ultraviolet sources were made in 1949. Seven electrocuter grids 36 in square were mounted 100 and 200 ft apart along the east edge of a 22-acre field of early-planted sweet corn (Fig. 4). Three traps used 100-w, type H-4, reflector mercury-vapor lamps and four traps each had five 30-w 360 BL lamps mounted on the grid frame. Two of the fluorescent traps had lamps mounted horizontally and two had them mounted vertically. Commercial electrocuter panels were used with the grid wires mounted horizontally (Fig. 5). Grid transformers were rated at 3500 v at a maximum current rating of 10 ma (milliamperes). The traps were controlled by a photoelectric relay set to turn the lamps on when the light intensity was below one foot-candle and off at levels of intensity of above one foot-candle.

No records of moth catches were made, but an intensive survey was made of the corn borer population in the field.

The average corn borer population in the plants in the portion of the field beyond 60 rows (200 ft) from the traps was 269 borers per 100 stalks. The traps reduced this population by 57 per cent to a distance of 46 rows (153 ft) from the lamps and by 69.5 per cent for 26 rows (87 ft).

Stalks, broken below the ears, were reduced by 52 per cent to 46 rows and by 65.5 per cent to 26 rows. On an average, 13.9 per cent of the stalks in the unlighted part of the field were broken. In evaluating these results it is necessary to remember that natural infestations may vary in different parts of a field. However, the results obtained were substantially in agreement with those previously reported by Ficht and Hienton (4).

Little difference was noted between the fluorescent types as far as the mounting plane of the lamps was concerned. The vertically mounted types, however, cover twice the area in a horizontal plane. Also, little *(Continued on page 532)*

Machinery Requirements for Stubble-Mulch Tillage

By G. E. Ryerson
MEMBER A.S.A.E.

STUBBLE-MULCH tillage is but one of the conservation practices affecting the job to be done by farm machinery. Others include not only the conventional practices such as terracing, strip cropping, contouring, etc., but such things as rotations, new crops, and even livestock management. In other words, conservation farming is simply a combination of all good practices which may be adapted to the needs of any particular community. The adoption of any practice, resulting in a change in the farming habits of the community, produces new requirements for farm machinery in that community.

Stubble-mulch tillage merely happens to be a practice which is very effective in controlling both wind and water erosion. It is also new enough that as yet there has been an incomplete development of its application and adaptability. Partially because of its newness and partially because its application represents a drastic change in the methods by which soil may be handled, machinery problems have been encountered in most places where it is used. Furthermore, stubble-mulch tillage is not a fixed thing. It varies from community to community, with different meanings in each community just as rotations vary between areas; and by the same token machinery adaptation to stubble-mulch tillage will vary as the practice itself changes.

In order to evaluate the machinery requirements for stubble-mulch tillage and other conservation practices, it is necessary to understand what must be accomplished by farm machinery when each of these practices is being followed. Before the necessity for practicing conservation was recognized, farming and farm machinery had developed in such a way that adequate seedbeds could be prepared, seed could be placed in the best position in the soil, weeds could be controlled and the crop harvested, all as economically as possible, with all too often little thought as to what happened to the soil.

In order to control erosion and maintain productivity there are other things that must be done simultaneously to the soil in addition to the job of merely preparing seedbeds, planting and harvesting crops. It is necessary that a protective cover either in the form of growing vegetation or as a mulch be maintained on the surface for as much as possible of that period of the year when erosion losses are most likely to occur.

In order to accomplish this, where stubble-mulch tillage is followed:

1 The tillage must be practiced in such a way to keep the proper amount of residue on or near the surface whenever it is needed

2 As a supplement to stubble-mulch tillage, the ground surface must be kept receptive to infiltration and resistant to erosion by both wind and water by maintaining a cloddy, roughened surface

3 Moisture losses must be controlled either by drainage and aeration in wet soils or by exclusion of air in the drier areas.

Frequently the changes which come with the adoption of conservation farming are of sufficient magnitude that the machinery in common use in that community is no longer as well adapted to the community needs as other machines already available. Farm implement dealers must recognize that the job of farming is changing in their areas and with it the job to be done by farm machinery. They should be in a position through a knowledge of the adaptability of all equipment, not just that which has been sold in the past but all other equipment in their company's line, to select and obtain the types and models which are best adapted to the new needs of the community. The farm implement dealer must also be in the position to advise and show his customers how the most benefits can be obtained from the adaptability of existing machines. All manufacturers make equipment with a multiplicity of attachments, modifications and accessories by which the characteristics of most implements can be changed appreciably. Through proper use of these modifications and changes much improvement in the adaptability of existing machines to new problems may be made.

The manufacturers must be prepared for a much more rapid than normal change in the historical pattern of distribution and production ratios between various models and types.

It is only after a thorough study of the adaptability of machines in current production that we come to a consideration of the necessity of incorporating new characteristics into the machines. I purposely do not say the development of new machines is necessary.

Since the principal part of the title of this paper deals with the machinery requirements of stubble-mulch tillage, consideration will be given that the phase of the conservation requirements for farm machinery. In discussing the specific requirements for machines, it is necessary to define the condition under which they be used. Therefore, these comments are directly related to the wheat-producing areas of the Pacific Northwest.

Whenever the quantity of residue is so small that it must be handled carefully in order to maintain a sufficient quantity on the surface for the time when it is needed, an undercutting technique is used for initial breaking of the soil in order to avoid all unnecessary mixing of the soil and the stubble. In such areas pretreatment of residue by either stubble shredders or disking should be avoided. Any pretreatment performed in these areas is done for two purposes only: to increase the intake of winter precipitation, or to aid in weed control by inducing fall sprouting of weed seed. Where such treatment is desirable it should be carried on in such a way as to disturb or break up stubble as little as possible.

The initial tillage job to be done in the light stubble area is to establish maximum depth of tillage by loosening soil to that depth. The stubble-mulch tillage limitations placed on how the job may be done are (a) minimum mixing of soil and mulch, (b) minimum breakage of mulch, and (c) minimum surface pulverization of soil.

The following initial tillage implements are adapted to the undercutting technique.

The Sweep Plow. This is a heavy plow-like implement and should not be confused with the lighter type of sweep used in secondary tillage. This implement cuts loose all roots and soil to the maximum depth of cultivation. The degree of pulverization obtained is dependent on soil type and moisture at the time of the operation. This tool is generally poor in producing sufficient pulverization and must be supplemented by secondary-tillage implements. It will not kill growing vegetation in the humid areas but is well adapted to this area. There appears to be little difference in the operation of the 90 or 120-deg sweeps as long as the sweep will shed. The high-lift sweep blades give better pulverization, but are more inclined to furrow the soil when it is loose at the time of operation. Nearly all the sweep bottoms, which are available now, wear out too fast and are definitely inferior in wearing qualities to plowshares. In this operation, sweep bottoms must perform the same function as the plowshare and should be made out of at least as good material. A coulter is needed on all sweeps when used in heavy stubble. In this application a coulter is used much more severely than on a plow since it must be placed to cut ahead of the point. Thus there is no relief for the cutting blade as it is forced into undisturbed soil by sheer weight and suck of the machine. The cone bearings used in plow coulters

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do not stand up for this operation either with or without grease. This implement also needs standardization and determination of the adaptability of various shapes of sweep bottoms.

The Spring-Tooth Plow. This machine acts as a heavy-duty field cultivator capable of working undisturbed soil to the maximum depth of cultivation and must be capable of penetrating at least 8 in. It is excellent in its pulverizing ability and somewhat better than the sweep in killing surface weeds when there is moisture present, but it will not kill perennial grasses. The tools available at the present time are generally used at depths beyond their structural strength in the heavy soils of the Pacific Northwest. For areas requiring deep cultivation, these tools should be stronger. The tool is decidedly limited in its trash-clearing ability; even the high-clearance machines are not generally adapted to moderately heavy stubble more than 2 ft in length. Tooth clearance and tooth chatter, structural strength and the installation of hydraulic lifts are all critical points in this machine.

The Rod Weeder. The rod weeder with shovel attachment is adapted only to light soils when used as an initial-tillage machine. Its penetrating ability is its one limiting factor in this area. It will rate excellent in pulverizing ability, trash clearance, trash placement and weed control. It has ample strength for those soils which it will penetrate but this application of the tool is, however, quite hard on the rod bearings.

In light stubble, summer-fallow areas, secondary tillage is usually confined to summer-fallow operations and generally does not offer much of a problem from the machinery angle. The requirements for such a tool are the ability (a) to control weeds and (b) to maintain a firm subsurface structure in order to exclude air and preserve moisture. All of these functions must be performed while maintaining a cloddy layer at the surface and without mixing residue with the soil

The Rod Weeder. Frequently the rod weeder is the sole implement used for this purpose. It performs all of the functions, which are necessary in this operation, very well in all soils which are free from stones, except that in some moisture conditions at seeding time certain small weeds will ride over the rod without being killed.

Field cultivator. Where stones are present in any quantity the field cultivator equipped with duckfoot shovels is usually substituted for the rod. It performs the same function, except that it does not produce the same degree of subsurface compaction as does the rod weeder. It is probably superior to the rod weeder in killing small weeds at seeding time in those falls favored by ample moisture. In areas where heavy mulch is brought into the summer-fallow season, it is necessary that the cultivator be equipped with spring-tooth shanks in order that the tooth chatter can assist in clearing trash. With a properly set up cultivator no difficulty should be encountered with trash clearance problems in this area.

The Rotary Hoe. The rotary hoe can lessen the weakness of both of these implements. It should be used in reverse in connection with the field cultivator to assist in subsurface compaction. When used as a hoe at seeding time it will aid the rod in killing weeds, and it will also help both implements to put the mulch and the ground surface in a good seeding condition. The light-weight types of hoe are excellent for this purpose under these conditions.

In the area of heavier rainfall that produces heavy yields of long straw both under summer fallow and annual cropping conditions, some of the residues must be broken down, either mechanically or by decomposition, in order to make the residue easier to handle in the preparation of a seedbed and in the planting of the crop. Under such conditions in fallow areas, fall pretreatment of stubble is frequently performed. The purpose of such pretreatment is (a) to shorten the length of stubble, (b) to increase infiltration of winter precipitation, and (c) to induce fall germination of wild oats and other annual weeds. The tendency in pretreatment operations is to overdo the job. The purposes are sound but treatment to perform each of them should not be so severe or inclusive as to destroy too much mulch. The following tools are used for this purpose:

The Stubble Pulverizer. This tool is very much in the formative stage and is not at all standardized, varying from overgrown rotary lawn-mower types of implements to hammer-mill types of beaters. It is believed that the ideal type of stubble treatment would be to merely shorten the length of straw into perhaps 12-in sections without undue shredding. This machine, of course, performs no function on the soil and

Fig. 1 Light mulch maintained on the surface after initial tillage by sweep and one rod weeding • Fig. 2 Moldboard plowing showing ideal feathering of mulch between furrow slices • Fig. 3 Rotary hoe being used as secondary tillage tool in stubble mulch. This tool is extremely valuable in spreading mulch and also as a tillage tool when properly used • Fig. 4 Coil-shank field cultivator being used as secondary tool in moderately heavy mulch. Tooth spacing and tooth chatter are two necessary features determining amount of mulch which can be handled with this tool

when used overdoes the job in light stubble or underdoes it in heavy stubble. The need or place of such a machine is not fully established although its use will make the job of using implements poorly adapted to stubble-mulch tillage much easier.

The Rotary Subsoiler. The rotary subsoiler is used extensively in some areas to break the surface soil into pits of perhaps a foot deep in an effort to obtain greater infiltration. Its effectiveness depends on the type of soil and the amount and intensity of precipitation as well as the depth to which winter frost penetrates. It performs little if any work on the stubble itself. It is useful on soils and in areas where stubble ground needs to be broken to absorb expected moisture.

The Disk Harrow. Implements of the disk type are more extensively used for this job than any other and may include the common tandem disk; oneway or wheatland plow or the heavy-duty orchard-type offset disk. These implements are capable of performing very useful functions in all pretreatment but, as used, the job is frequently overdone from the standpoint of producing excessive destruction of mulch. Also, because of the speeds at which they are used, surface pulverization is so great as to produce conditions which cause the ground to seal over and thus reduce infiltration rather than increase it. The disk is most effective in inducing fall germination of weed seeds, and if properly used can be valuable in its action in the stubble. In order to be most effective under varying field conditions the disk harrow should be equipped with hydraulic controls, either as angle controls or as wheel-depth controls.

INITIAL TILLAGE OPERATION IN HEAVY STUBBLE

The initial tillage operation in the heavy-stubble areas are usually performed in the spring for summer fallowing and in the fall for the annual cropping. Where fall tillage is done, there is usually no pretreatment unless it is found necessary to shorten the straw in order to assist tillage operations.

The jobs to be done in initial tillage and the stubble-mulch tillage limitations are (a) to establish maximum depth of tillage, (b) to loosen the soil without excessive surface pulverization, and (c) to mix the residue with the soil so that sufficient quantity is on or near the surface in order to provide adequate control of erosion. The proper placement of residue will vary considerably depending upon the subsequent operations that are to be performed and the type of implements available for performing them.

The Moldboard Plow. This tool can be made to produce almost any desired condition either as a standard plow or by removal or modification of the moldboard. When used for fall tillage in annual cropping areas, the ideal job will show a uniform feather of mulch protruding from between each furrow with a minimum amount of soil pulverization. One weakness of the moldboard plow for this purpose is excessive pulverization and throw at the speeds at which it is usually operated. If there can be some way to reduce excessive pulverization and mechanical soil movement, the moldboard plow would be capable of producing ideal conditions. In the summer fallow areas, the moldboard plow is generally used with a modified moldboard or without a moldboard to place more mulch on the surface. The plow as usually used has a tendency to bunch loose straw or to clog. The principal cause of clogging is defective coulters. A properly adjusted plow or at least 16-in bottom, having a good, well-adjusted coulter will handle large amounts of residue without difficulty. There are two basic causes of coulter problems: improper adjustment and care and the fact that bearings, yokes and shanks are not quite strong enough to stand the job imposed upon them for a sufficient length of time to prevent the farmer from getting discouraged in trying to keep them in adjustment.

The Oneway or Vertical-Disk Plow. In the Pacific Northwest where tillage is performed at depths of from 5 to 8 in, the oneway produces excessive pulverization, throw and cover at the speeds usually operated. Also, at these speeds there is a tendency to place too much of the residue at about 3 in below the surface, just in a position where it is most difficult to work out with secondary tillage implements. There has been some thought that certain of these undesirable characteristics could be alleviated by using disks of a flatter curvature. The oneway, if used at speeds well below 2 mph, will produce very satisfactory results.

The Heavy-Duty Orchard-Type Disk. This tool is also apt to cover excessively but it is not as objectionable in this respect as the oneway. This is mainly because available sizes of this implement load the tractor to the extent that speeds are not generally excessive. The heavy-duty orchard-type disk also cuts the straw in shorter lengths so that subsequent operations are more easily performed. Because of these characteristics it has replaced large numbers of both moldboard and oneway plows in the last few years and will probably continue to replace them.

The Disk Plow. This tool is capable of performing probably the most ideal job of any of those previously mentioned. The soil can be thoroughly broken without excessive pulverization, mulch can be placed at almost any location or mixed as needed and it will handle heavy stubble without trouble. In order to perform such a job, it is necessary, however, for both dealers and farmers to learn how to adjust the disk plow to produce the desired condition as it is most critical to its adjustment. There appears to be an excellent field for this tool in all the heavy stubble areas if an increased volume of production can reduce the price. The principal comment heard on this tool by farmers is that they wish they could afford it.

The Sweep Plow. This is the one tool of those mentioned in this group which does not produce enough surface pulverization. It has the advantage of enabling the proper degree of pulverization to be produced by the supplemental tillage operation and of causing the least amount of mechanical movement of soil downhill. It is believed that this tool will have a definite place in all of this area if for no other reason than because it is better adapted to killing sweet clover at the proper time than any of those previously mentioned. Sweet clover is now being grown extensively in rotation in all of this area. In handling it, it is necessary that a positive kill be effected at exactly the proper time. This is impossible with any of the disk implements. The moldboard plow will do the job but unless extreme care is used, the soil is left in an extremely erodible condition. In this operation, it is necessary to leave the maximum amount of clover residue on the surface in order to provide the necessary protection against erosion. The sweep performs this function well but here again this tool needs bottoms that will stand up better.

CHOICE OF IMPLEMENTS DEPENDS ON NATURE OF WORK

The most satisfactory secondary tillage implement for the heavy stubble areas will depend on the work to be accomplished. The jobs which must be done are (a) the preparation of a firm compact subsurface seedbed without excessive surface pulverization, and (b) lifting of the crop residue from the area being tilled and the maintenance of uniform mulch on the surface.

This involves spreading of straw mulch as well as clearing stubble from the upper layer of soil. These functions must be performed with a minimum amount of clogging.

The Rod Weeder. The application of which is similar to that in the light-stubble area, except that when initial tillage has been performed in such a way as to include large amounts of stubble in the area from 3 to 4 in below the surface, it is extremely difficult to operate the rod without clogging. Usually when initial tillage operations have been done with the oneway, offset disk, or with the moldboard plow having the moldboard on, it is necessary for the first operation to be done with the field cultivator.

The Cultivator. When the cultivator is properly adjusted, it will clear the area at which the rod is to operate of excessive stubble and bring it to the surface so that subsequent fallowing operations can be performed by the rod. In the annual cropping area, the field cultivator frequently will be the only tillage tool used, and it is the most satisfactory of all tillage tools now available for use in preparing seedbeds where the mulch has been well mixed with the tilled layer. It is necessary that the cultivator be so constructed that the lateral spacing can be varied to meet existing conditions. It is also necessary that there be maximum *(Continued on page 510)*

An Experimental Mulch Planter

By R. R. Poynor
MEMBER A.S.A.E.

THE trash residue system as a means of controlling soil losses, increasing moisture retention, and keeping the soil in good physical structure, is fundamentally sound. The greatest problems appear to be mechanical rather than cultural, and the mechanical solution to these problems varies from region to region with changes in soil type, climatic conditions and cropping practices.

In the paper by G. E. Ryerson, published elsewhere in this issue, is a careful analysis of the methods and existing machinery now being successfully used to accomplish stubble-mulch tillage in the less humid Pacific Northwest wheat belt. As we move into the corn belt, the increase in rainfall makes it increasingly difficult to obtain a satisfactory destruction of the existing vegetation while still leaving it on the surface where it is needed for protection against rainfall erosion and surface sealing. While this job can be done with existing machines, I am of the opinion that in the case of the corn crop, a machine designed specifically for the job will give better performance in the utilization of time, energy and fertilizer.

Recently, the International Harvester Company has been experimenting with mechanical equipment designed to produce a corn crop under the trash-residue system. Fig. 1 shows an experimental mulch planter which was used on the Company's Hinsdale, Ill., Farm this past season. This planter may be used in undisturbed ground to till, plant and fertilize in a once-over operation; or if necessary, preliminary tillage with a disk, chisel tooth, or sweep may be performed the previous fall or in the early spring. If preliminary tillage is performed, the planter will work better if time is allowed for a rain to firm the surface before using it.

The machine consists of a front-mounted tillage unit and a rear-mounted planting unit. Functionally it performs as follows: An upper 30-in sweep shears the soil at a depth of 2 to 2½ in below the surface where most damage to the roots of existing vegetation can be accomplished. A lower 25-in subsweep loosens a rootbed to a depth of 7 to 8 in. Fertilizer is banded at an 8-in depth through a fertilizer boot directly behind the lower sweep. This can be a heavy application since it will be 5 or 6 in below the seed. A combination rolling coulter and gage wheel is mounted ahead of the front sweep. Four rotary-hoe wheels function to produce an 8-in strip of seedbed, cover the fertilizer and compact the rootbed, and drive the deep application fertilizer hoppers. Trash rods extend around the hoe wheels to allow loose dirt to filter back into the planting furrow while excluding surface trash. Planting is accomplished with stub-runner openers mounted on the rear. These may or may not be equipped with disk openers depending on surface trash conditions. Disk coverers and press wheels complete the planting job. A conventional split-boot fertilizer attachment applies a shallow application of starter fertilizer from rear-mounted fertilizer hoppers. These hoppers and the seed plates are driven from the rear axle of the tractor. Planting in 40-in row widths with 30-in front sweeps leaves 10-in undisturbed strips in the middle. These can be removed with three smaller sweeps mounted in the manner of a cultivator rear section. Then by replacing the front tillage unit with a conventional cultivator front section, the tractor is equipped to cultivate.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution of the Power and Machinery and Soil and Water Divisions.

The author: R. R. POYNOR, farm practice research, International Harvester Co., Chicago, Ill.

Fig. 1 International Harvester experimental mulch planter showing front-mounted tillage unit and rear-mounted planting unit

Equipped as shown in Fig. 1, the planter taxes the IH Model M tractor to its maximum tractive capacity, even with wheel weights and liquid in the tires. This is not surprising considering that an 80-in strip (two 40-in rows) is receiving a shallow undercutting and 50 in (two 25-in widths) is being loosened and undercut to an 8-in depth. With a lighter tractor, such as IH Model H, or in very heavy soils, the three-sweep rear section might have to be eliminated and the middle strips destroyed during cultivation. The other alternative is to resort to narrower row spacings.

The planter was used under several different surface conditions on the Hinsdale farm in the spring of 1949. It was used to plant in an alfalfa sod which had no tillage treatment previous to planting. The alfalfa was cut and shredded with an experimental residue shredder just before planting. The machine performs as intended when the surface appears relatively undisturbed and free from bunching and piling of trash. If the resulting surface condition is too loose and cloddy, one trip over with a corrugated roller will result in the desired improvement.

Fig. 2 shows the appearance of another field—an alfalfa-brome sod—about 10 days after planting with the mulch planter in a once-over operation. The corn is just emerging. An effective erosion-resistant cover has been maintained in the middle while the row is free of trash and weeds. The trash-free rows will facilitate cultivation.

A conventional 2-row cultivator equipped with disk hillers did a satisfactory job of controlling weeds. The disks were set to throw out slightly during the first cultivation and in for the second and third. Flat sweeps set to run 1 or 2 in deep were used behind the disks. Cultivation under the stubble-mulch system is not the problem that first consideration sometimes makes it seem. The heavy cover of surface trash and the coarse cloddy condition of the soil surface prove very effective in preventing or retarding germination and growth of weeds.

Fig. 3 shows an alfalfa strip after the third cultivation. By this time the residue has undergone considerable decomposition and mixing with the surface soil, but there is still enough present to afford considerable physical protection against erosion and surface sealing.

Although no attempt was made to run a carefully controlled experiment, yields from the mulch-planted strips were measured along with yields from adjacent strips conventionally tilled and planted. The mulch-planted strips gave definite increases in yield (in one instance more than double) over the conventional strips. The mulch-planted corn received 500 lb of 8-8-8 fertilizer in addition to the 200 lb of 3-12-12 starter that both the mulch and conventional planting received. We attribute the increase in yield to the extra fertilizer rather than the mechanical treatment. However, the use of the mulch planter with the extra fertilizer was definitely a paying proposition, and at the same time a very sound conservation practice was being put to work for the good of the soil.

No record of time and power requirements was made, but it was obvious that they were less for the mulch planting.

It is hoped the report of this work will help further the cause of the stubble-mulch practice for the corn belt region. The farm equipment industry is anxious to build machines that will give best results with least harm to the land. The future of this or any machine of a similar nature will depend to a great extent upon the success of the agricultural experiment stations, the Soil Conservation Service, and other agencies in selling a new system of handling crop residues to the corn belt farmer.

Machinery for Stubble-Mulch Tillage

(Continued from page 508)

clearance both vertically and fore and aft. No tooth may be closer to a wheel than it is to other teeth. Even so this is the most frequent point of clogging. Curved shanks are necessary to lift the residue, and the shank must be so shaped that it is receding at the ground surface. Maximum tooth chatter must be obtained to reduce clogging. Even at best some difficulty with clogging will be encountered except under the most ideal conditions. Hydraulic lift controls are practically a necessity to make this operation successful.

The Disk Harrow. It is used in tillage operations when a condition has been produced which cannot be handled by the cultivator. It is of course possible to produce a seedbed with a disk harrow but in so doing the mulch is buried rather than raised to the surface. Because of the extreme fineness of the ground surface which is produced, most of the effectiveness of the mulch is lost when the disk harrow is used for seedbed preparation.

The Rotary Hoe. A heavy-duty rotary hoe has been adapted from the purpose for which it was designed to a very useful tool for seedbed preparation. The rotary hoe it better than any other tool for spreading mulches uniformly. It will raise mulch to the surface and it will break up long straw. When properly used, it is a sufficiently drastic tillage tool for many conditions and, since it is a rotating tool rather than a toothed tool, it is self-cleaning. Furthermore, it has the very desirable characteristic of doing better work as the speed is increased. The one weakness of this tool is that presently available hoes were never designed for this use, and are not sufficiently sturdy to stand the strain imposed upon them. When used in heavy stubble, it is necessary that the tandem-gang type with overlapping hoe wheels be used in order that the two gangs can clean each other. It is believed, however, that this feature could be incorporated by using bar cleaners between each hoe wheel in a single-gang type. If such is the case, a more drastic tillage tool can be readily made by operating a single-gang type on a sufficient skew to provide necessary tillage by dragging each tooth through the soil a short distance before it rolls out and is replaced by another tooth. Here again, we need more strength and thrust bearings. It is my belie that a machine of this type, which we might call a rotary oothed harrow, will eventually prove to be necessary for eedbed preparation in heavy stubble areas. I am quite certain hat, if such a tool were available and one that would st nd up mechanically, it would supplant both the field cultiva r and the rod weeder in at least the annual cropping portio of the heavy-stubble area. This tool will not only do the kin of job we need done on the mulch, but it will do whateve job is necessary on the soil. By changing the direction of tra l and by operating at variable angles, the type of work done on the soil can be modified to meet almost any condition whi n may be encountered.

In all areas, stubble-mulch tillage adds the job o penetrating available mulch to the job of drilling. This ust be done with little if any clogging. The problem of drillin is not difficult in either the light or the moderately heavy tubble areas. In the light-stubble areas almost any type of d ll can be used except that the double-disk furrow openers are not satisfactory. In the moderately heavy-stubble areas, sin le-disk openers of the semideep furrow type are generally ad quate.

In the heavy-stubble areas, the most satisfactory opener is either the single-disk deep-furrow type or the lister type. The relative merits of each of these seem to be largely a matter of personal preference.

Press-wheel carriages are advantageous with both types since neither will penetrate all of the mulch, and the press wheels will assist materially in obtaining germination of the seed. These two openers, when used in conjunction with the press-wheel carriage, are adequate for most conditions, but I am not too sure that improvements cannot be made for drilling in heavy stubble.

I have had the suggestion of a drill using the rotary principle, such as mentioned in connection with a rotary hoe. In such applications the seed would be planted in pockets rather than in rows. The first advantage is that no amount of mulch would be troublesome and further clogging could not occur. Such clogging is a very real problem when drills are operated in squadrons of as many as six and when conditions suitable for drilling may be of very short duration and require high-speed work when suitable conditions prevail.

In stubble-mulch tillage and all conservation work, the importance of hydraulic controls cannot be too strongly stressed. Frequently tools which would not be at all satisfactory with either hand or clutch type of lifts, can be operated fairly well when operated with hydraulic controls. Relief of the tool can be given at the proper time to relieve incipient stoppages. In addition, hydraulic controls are almost a necessity for some of the very heavy tools now being used. Certainly, if we expect to protect grass waterways, terrace outlets, or other conservation structures in all large-scale farming areas we must provide positive, accurate and easily operated means of raising or deangling implements.

Fig. 2 *(Left)* An alfalfa-brome sod as it appeared 10 days after planting with the mulch planter in a once-over operation • Fig. 3 *(Right)* orn after the third cultivation which was mulch planted in an alfalfa sod strip

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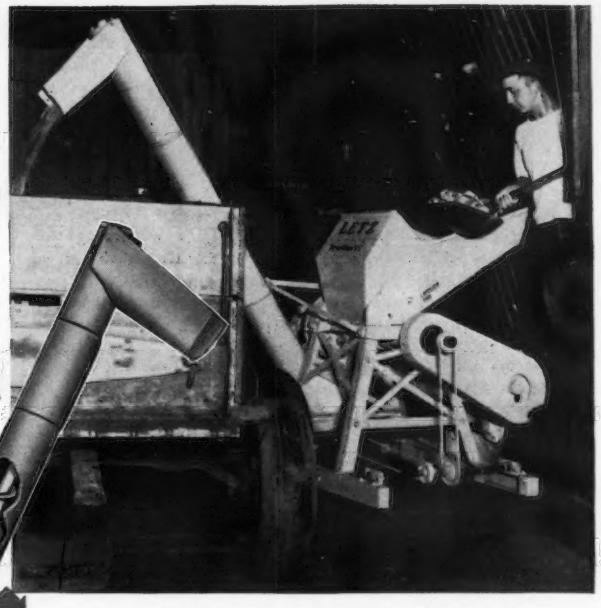

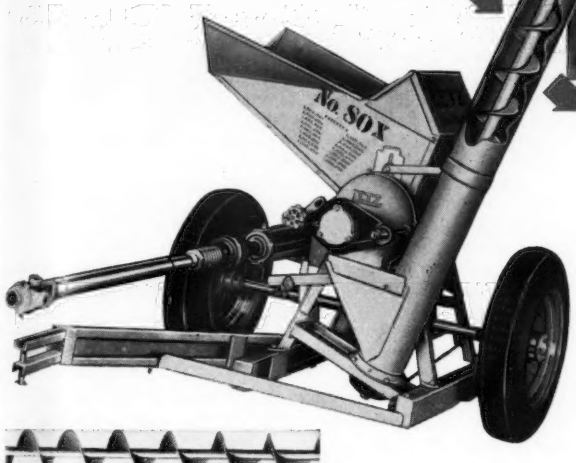

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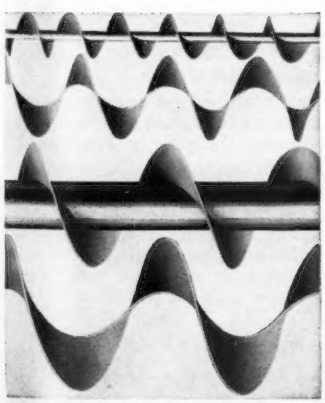

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A Corn Picker with Stalk Shredder

By A. H. Keller
MEMBER A.S.A.E.

INTERNATIONAL Harvester Company is interested in soil conservation practices and maintains a farm practice research division for the purpose of working with various governmental and other agencies in developing new practices and methods to better meet the problems that continually plague the farmer. It is through such cooperative effort that some of the basic design in our new machines is determined. This is an important factor as it enables us to incorporate in some new machines the ability to combine normal farm operations with conservation practices.

This is particularly true of a new-type corn picker which our company has in the development stage. While this new machine is adapted specifically to but one crop, it is important to note that corn is grown on a greater acreage than that of wheat, oats, barley, rye and rice combined. The total acreage planted to corn in the United States in 1949 was approximately 87 million acres, 75 per cent of which, it is estimated, was harvested with mechanical pickers. The ever-increasing popularity of mechanical harvesting of corn, coupled with the abundance of residue left in the field as a result of greatly increased yields, now presents a problem of considerable magnitude for subsequent farming operations, but which, at the same time can become a boon to conservation practices if the cornstalks are processed to derive the benefits from them.

Fig. 1, for example, represents the condition of the average corn field after a corn picker of conventional design has harvested the crop. That is, the ears of corn are removed by means of the snapping rolls which permit the cornstalks to pass through them but generally leave the stalks in much the same condition as they were before the machine passed through them. Of course, there are now machines on the market that process the cornstalk residue, but an additional operation is required and in some instances the pattern of the material left in the field by the corn picker, as shown in Fig. 1, presents the problem of being able to do an efficient job. The fact that these machines have come into being emphasizes the need for a machine such as the one on which we have been working.

The machine we have had under development for several years in various designs departs from the principle embodied in corn pickers of conventional design. The cornstalk is cut off in a similar manner to that of the conventional corn binder, but the cutting mechanism, while much the same as that used in a corn binder, cuts off the stalks at the ground line which is important in the job we are endeavoring to accomplish. After the stalks are cut off, they are conveyed into the machine by means of chains and pressure devices which in turn deliver the butt ends of the stalks into snapping rolls which remove the ear corn in essentially the same manner as do present conventional corn pickers. However, it is of importance to note that the entire corn plant has been taken inside the machine and, after removing the ear corn and delivering it into a trailing wagon, the stalks are expelled from the machine and returned to the soil.

There are numerous advantages from the harvest angle alone in this design, but I wish to point out that in the process of returning the stalks to the soil we employ a shredding device. This device primarily consists of a high-speed rotor that is located beneath the snapping rolls throughout their entire length. It can be assembled from a variety of equipment ranging from stationary hammers, swinging split hammers, shredder bars or combination knives. There is also an adjustable stationary bar or concave either of which is positioned in the proper relationship to this rotor, together with necessary shielding and deflector sheets.

The purpose of the rotor and its related parts is to shred, chop or pulverize all the material that passes through the snapping rolls and then deliver it to the soil in an even cover over the area between and adjacent to the rows cut out. Fig. 2 shows a section of field from which the ear corn was removed by this new machine equipped with the shredding or pulverizing device.

It is quite obvious that the results obtained from a machine of this type would be quite desirable from several angles, namely:

1 The chopped and shredded condition of the residue

2 The highly absorbent quality of this residue resulting in faster decomposition

3 The blanket effect created over the soil

4 The retention of moisture by this blanket

5 The field left in excellent condition for disking or plowing, compared with the former method generally requiring a separate operation of stalk cutting, chopping or shredding

6 The stalks are more readily made available to the soil, because of quick decomposition

7 The destructive effect on the corn borer not only from an outright mechanical kill, but also from the standpoint of making possible cleaner plowing. Incidentally, our tests showed a mechanical kill of as high as 98 per cent of the borers in the stalks.

(Continued on page 534)

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution of the Power and Machinery and Soil and Water Divisions.

The author: A. H. KELLER, chief engineer, East Moline Works, International Harvester Co., East Moline, Ill.

Fig. 1 *(Left)* Average condition of a corn field after a corn picker of conventional design has harvested the crop • Fig. 2 *(Right)* Condition of a field from which the ear corn was removed by means of new corn picker (in the development stage) equipped with a device for shredding or pulverizing the cornstalks

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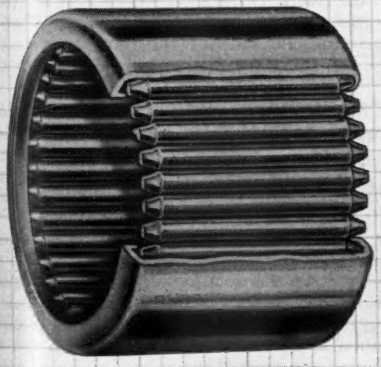

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Hydraulic Controls and Soil Conservation Implements

By H. E. Pinches
MEMBER A.S.A.E.

TWO sentences near the beginning of Mr. Ryerson's paper caught my attention. He said, "Conservation farming is simply a combination of all good practices which may be adapted to the needs of any particular community. The adoption of any practice, resulting in a change in the farming habits of the community, produces new requirements for farm machinery in that community."

Improved practices must be made easy for the farmer to carry out; particularly improved practices for soil manipulation or crop handling must be made easy for the farmer to do with his own implements. In light of this, hydraulic controls appear as a key to the spread of at least part of the good practices of conservation farming.

Hydraulic controls—whether on tractor-integrated equipment or trailing equipment—have introduced new elements of ease and precision of operation. Equipment is now responsive to the judgment and purpose of the operator in a way that earlier designs never provided. This ease and precision of operation is especially important for conservation farming.

Grassed waterways, for example, are control measures that should be installed and maintained on millions of acres. Why are these simple, obvious, and practical gully-stoppers still so scarce? Probably, because they have been, until recent years, so hard to manage. The farmer could work his land from strip to strip, that is, break up his large field into smaller fields of irregular shapes bounded by the strips of grass. Or he could do his best to cross the strips at the cost of a great deal of hard work and delay, and considerable damage to the grass sod in the waterway. Either choice was discouraging.

If he did get his plow out of the ground at the right point, across the waterway without damaging the grass, and into the ground again without delay, the grass was still far from established for a season of vigorous growth.

As the farmer worked down his plowing with disk and spike-tooth harrows, the grass in the strips was treated pretty roughly. What the disk harrow did not cut up was bruised and torn by passage of the spike-tooth harrow, or buried by soil dragged in by either or both implements.

Next came the planter or drill. If not lifted and thrown out of gear at each crossing of a grass strip, valuable seed and fertilizer were lost. That in itself was enough to keep grassed waterways shrunk to the narrow, ineffectual strips so generally seen where any grass is left at all. Finally, and in the same season, came the cultivator to take its toll of the grass with its repeated crossings.

Let us look now to the changes in practice possible with implements operating under hydraulic controls. The improvements to be pointed out are probably functions not only of hydraulic controls but also of integration of implements with the tractor.

Grassed Waterway. The grassed waterway has two essential specifications, namely, (a) wide enough and extending high enough on the adjacent slopes to carry the peak runoff from all normally severe storms, and (b) smooth enough and flat enough in the center that implements can cross easily without delay, or damage to implement, or discomfort to the operator.

A third specification might be added. Due to runoff from the higher areas, the land in the strips will get more water than the rain which falls on it and also some transposed fertility, both being conditions favoring growth of grass. Generally the only way this grass can be harvested efficiently will be through harvesting it for hay. Some thought, then, should be given to making the sides of the strips parallel in so far as practical, and the transverse dimensions of the strips to be even multiples of the normal swath of the farmer's mowing machine.

However, as already indicated as one of the essential specifications, these strips need considerable width to be effective and, consequently, occupy significant acreage. The dynamic, positive view is that these strips are hay fields, whose number, shapes, and locations are determined by the topography of the farm. Hence, they become as important, acre for acre, as any other forage-growing area on the farm and should be treated accordingly.

Blade Grader. The tractor-mounted blade has a wide variety of uses such as building and maintaining terraces and terrace outlets, building and maintaining farm roads or lanes, ditching, plowing snow, and many other uses according to the type and location of the farm.

It is an implement of wide general utility which may be used, in the circumstances we are discussing now, by the farmer alone and as he can get to it between other jobs, to smooth and shape the areas to be developed as grassed waterways; to fill any small gullies which had developed and to build temporary by-pass channels, if needed, to protect the waterway while the seeding is getting established.

All controls are available to the tractor operator. The angle of the blade, its tilt, or its pitch can be changed without leaving the tractor seat. And the depth of cut of the blade, under finger-tip hydraulic control, can be varied in an instant and without effort from the lightest shaving to a full cut. Then, to clear the blade of trash, or for transporting it to and from the job or deadheading on the job, the same hydraulic controls lift it a couple of feet off the ground.

Plow. A plow mounted and subject at all times to hydraulic controls is so easy to raise and lower that any operator capable of driving the tractor can cross grassed waterways without damaging them and without fatigue other than that normal to a day of plowing. It is so positive in its action and so uniform in its cycling intervals, that it is possible to lift and lower the plow with the precision of timing necessary to maintain even and parallel sides for each strip.

Disk Plow. For areas where disk plows are used, a plow fully-mounted on the tractor provides the same ease of crossing the strips of grass as with the moldboard plow. When it is in transport position, no part of the plow touches the ground, and only the rubber-tired tractor wheels touch the grass.

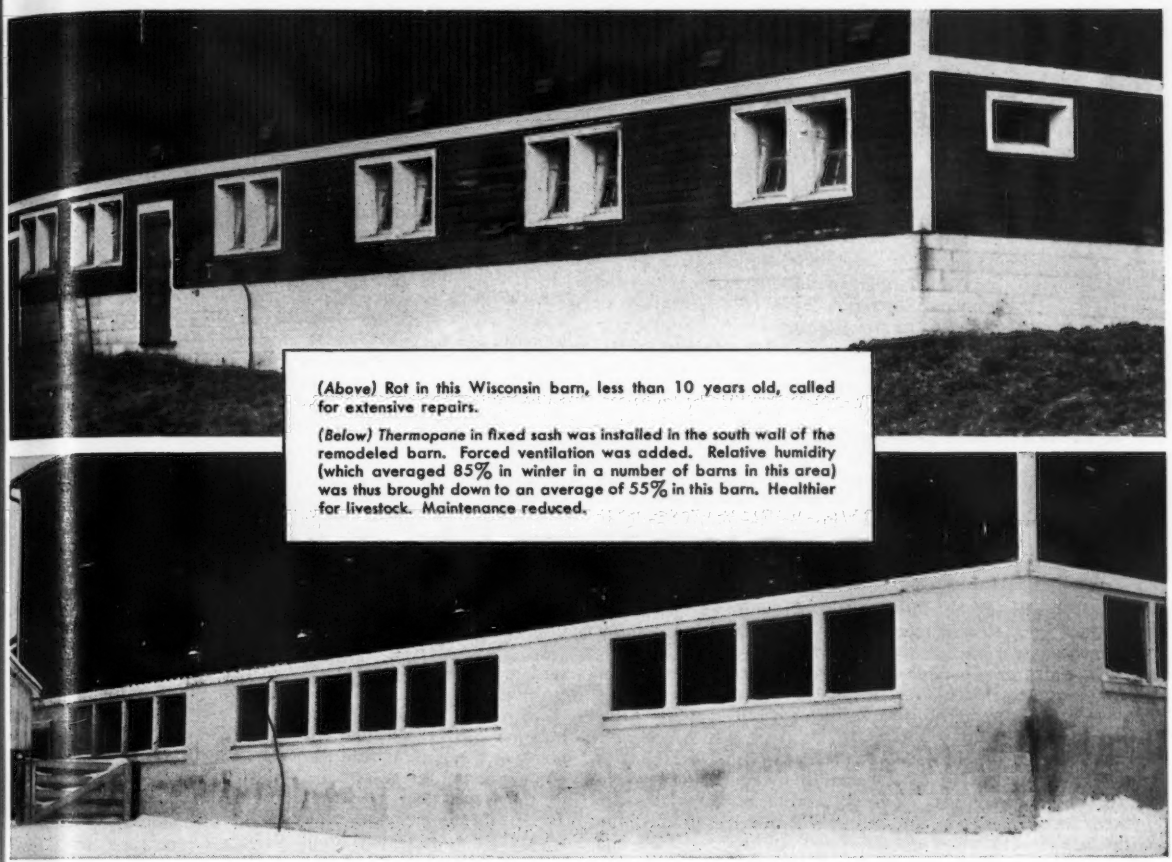
Disk Harrow. Next to the plow, the disk harrow has probably been the greatest mechanical hazard to grassed waterways. What was needed was some way to straighten out the gangs so that the disks could roll over the grass without cutting but re-establish the cutting angle promptly after crossing the strip. In our tandem-disk harrow, the hitch has been so designed that operation of the hydraulic control takes cutting angle out of the gangs or restores cutting angle without stopping, or even slowing down the tractor. (NOTE: A few months after presentation of this paper, a *tractor-mounted* tandem disk harrow was put on the market. It provides all the facility and ease of operation of the other implements which can be lifted and carried over the grassed waterway, and eliminates entirely any damage to the waterway).

Spike-Tooth Harrow. The four-section spike-tooth harrow is just as easy to raise as the plows for crossing a waterway, again without slowing down and without operator fatigue. Also, if the harrow were gathering any trash, the tractor driver could, by properly timing his operation of the hydraulic control as he approached the boundary of any grass strip, leave the trash on the tilled area or drop it on the grass as he chose.

(Continued on page 516)

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution of the Power and Machinery and Soil and Water Divisions.

The author: H. E. PINCHES, assistant to executive vice-president, Harry Ferguson, Inc., Detroit, Mich.



(Above) Rot in this Wisconsin barn, less than 10 years old, called for extensive repairs.

(Below) Thermopane in fixed sash was installed in the south wall of the remodeled barn. Forced ventilation was added. Relative humidity (which averaged 85% in winter in a number of barns in this area) was thus brought down to an average of 55% in this barn. Healthier for livestock. Maintenance reduced.

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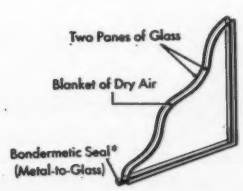

Equipment for Reduction of Crop Residues

By R. M. Merrill
MEMBER A.S.A.E.

IN his paper Mr. Ryerson has explained in some detail the function which surface mulch fulfills in the protection of soil from erosion and in the retention of moisture by the soil. The advantages of holding a mulch of some type on soil unprotected by growing vegetation have been accepted for years in many areas, but the practice has usually raised problems connected with the necessary tillage and planting operations through the mulch. However, we now have several areas where the problems are being solved. Mr. Ryerson has discussed the various methods used in the Northwest.

In addition to those areas where the retention of crop residues on the surface of the soil as a mulch is important, there are many areas where the surface mulch is not so necessary or practical but where it is desired that the residues be incorporated in the upper few inches of soil. To simplify the mixing of the residues with the soil, whether by plowing or disking, the materials may be reduced considerably, especially in such crops as corn and cotton.

Machines of several different types are now being sold for the reduction of crop residues. These machines—usually operated by power from a tractor—chop, shred, cut or beat the stubble, stalks or other plant material and scatter it over the soil surface. Attachments for combines are available which cut the grain or bean straw and scatter the cut material as it comes from the combine strawrack.

Few of these machines were developed primarly as aids to mulch farming, but in most cases to make the subsequent tillage operations easier. If heavy cotton or cornstalks are broken, shredded or cut, the refuse will disintegrate and mix with the soil with much less interference with cultivation and other operations than offered by untreated stalks.

In those areas where clean cultivation is advocated and practiced for insect control the use of a surface mulch will probably not be considered. However, in the European corn borer infested area it is believed that a good job of beating or shredding cornstalks will directly kill or expose to the elements a good proportion of borers and will leave the material in such condition as to offer much less desirable shelter for the borers which survive the shredding process.

In areas where a surface mulch is desirable, this type of equipment usually can be adjusted to give about any degree of residue reduction. It is well to remember Mr. Ryerson's statement that residues can be overtreated or reduced to such an extent that the material will disappear too rapidly to serve as an effective mulch. In light crops it is apparent that such would be the case.

The machines differ considerably in detail as to type of knives, beaters or shredder bars used, and how they are arranged and driven, but they all seem to do an acceptable job of reduction of crop or residues. Some are designed particularly for best performance in row crops and others for most effective use in drilled or broadcast crops.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution of the Power and Machinery and Soil and Water Divisions.

The author: R. M. MERRILL, agricultural engineer, Deere & Co., Moline, Ill.

Fig. 1 John Deere two-row stalk cutter being used to shred cornstalks and spread the residue evenly on the field. The machine has four sets of high-carbon reversible rotating blades for each row

Hydraulic-Controlled Implements

(Continued from page 514)

Grain Drill. The grain drill in any practical width, with its varying load of seed and fertilizer, is too heavy to mount easily on the tractor. Also, it needs end wheels (or press wheels) for depth gaging. The same purposes as before are served by arranging the hitch so that the same operation of the hydraulic control which lifts tractor-mounted implements results, in this case, in lifting the furrow openers and throwing the fertilizer and seed runs out of gear. Again, the grassed strips can be crossed without damage and without loss of seed or fertilizer.

Planter. A drill planter for following contours is raised and lowered by the same means as other implements already mentioned. Being ground driven, it is out of gear as soon as it leaves the ground, and the flow of seed and fertilizer stops while crossing the grass.

Cultivator. The row-crop cultivator is raised just as easily as the other implements, and as frequently as needed, to cross all grassed waterways without damage.

Power-lifted tractor cultivators have, of course, been available for quite a few years. This type is mentioned here to emphasize that it is now possible for anyone operating a one-man farm, with one tractor and a few unit implements, to go all the way in establishing and maintaining really effective grassed waterways, without additional outside help either of labor or specialized machines.

Now what about the forage to be harvested from waterways? Considering them now as narrow, winding hay fields focuses attention on the mower and rake.

Mower. Mounting the mower on the tractor, and lifting it by means of hydraulic controls makes an easily handled outfit. Cutting any given acreage of hay crop in these strips will require more maneuvering of the tractor and cutter bar than in large rectangular fields. The facility added by hydraulic controls and tractor mounting is a real help.

Side-Delivery Rake. One of the most awkward implements to use on narrow grassed waterways is the conventional side-delivery rake. The rake that is entirely tractor mounted does not touch the ground when raised by hydraulic controls. As a short-coupled outfit it can be turned around in a very limited area. The rake can be lifted and backed into all corners. When finishing strips whose sides are not parallel, or when passing from one strip into a joining strip—conditions under which it may be necessary to cross one or more windrows—only the tractor wheels would disturb windrows previously raked.

Much of what I have been discussing has been available for a number of years in one form or another in the machines offered by several companies. But until all the machines needed and used by a farmer in any sequence of tillage, planting, cultivating, and harvest are adapted to a conservation practice, the unadapted machines will be major obstructions to any widespread adoption of that practice. It is the old story that a chain is no stronger than its weakest link.

I have been attempting to show that there is in the machinery now available to the average farmer no longer any obstacle to farmers everywhere establishing the millions of effective and productive grassed waterways that are needed.

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Results of Rainfall and Runoff Studies

By John A. Allis

MEMBER A.S.A.E.

MOST soil conservation practices on a farm deal with the conservation of water, storage of water or the disposal of excess water. In order to predict the peak rates of flow and volume of surface water for the economical design of conservation structures, actual measurements of runoff are needed. Several empirical formulas and charts have been developed, based on short periods of record, observations and assumptions. Most of these data have been developed for a specific area and for certain conditions. Valuable information is being obtained by actual experience which of course is a costly way of arriving at proper design values. Experiment stations have contributed some valuable information. However, our total knowledge in this field falls far short of requirements. This is especially true since we are using more and more water-control structures as land is put under a soil-conservation program. The following criteria are often used: A diversion ditch, terrace or other small structure should be designed for a runoff frequency of one year in 10, and small earth dams one year in 25. Large earth dams or where failure may cause considerable damage should be designed for runoff frequency of one year in 50, and for large structures, where life may be endangered, for one year in 100 or more frequency.

Rainfall and runoff studies were started in 1938 on the Central Great Plains Experimental Watershed, near the village of Rosemont, in Webster County, Nebraska, 25 mi south of Hastings. It is one of three hydrological experiment watersheds in this country. The others are located at Coshocton, Ohio, and Waco, Texas. This watershed is a tract of land of about 5,300 acres and drains into the Republican River basin. The data collected are applicable to about 70 counties in south central Nebraska and north central Kansas. With modifications to allow for differences in soil, rainfall, etc., they can be used over a large section of the Great Plains.

The average yearly rainfall at Hastings since 1895 is about 24.5 in. During this period it has varied from 11.9 to 40.6 in. Seventy-four per cent of the rainfall occurs in the 6-mo growing season from April to September. *(Continued on page 520)*

This paper was presented at a meeting of the Mid-Central Section of the ASAE at Lincoln, Neb., April 1950. It reports the results of studies on a project of the SCS Central Great Plains Experimental Watershed, Hastings, Neb., in cooperation with Nebraska Agricultural Experiment Station.

The author: JOHN A. ALLIS, project supervisor, Central Great Plains Experimental Watershed, Soil Conservation Service, U. S. Department of Agriculture, Hastings, Neb.

AUTHOR'S NOTE: Grateful acknowledgment is made to Dr. F. L. Duley, J. C. Russel and others for their suggestions in editing this paper.

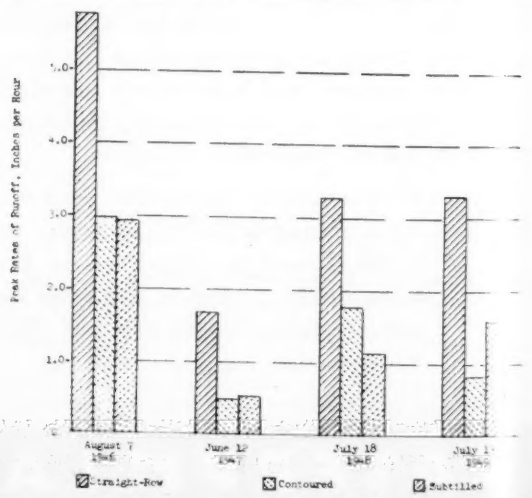

Fig. 1 Average maximum peak rates of runoff from corn watersheds for selected storms, 1946-1949

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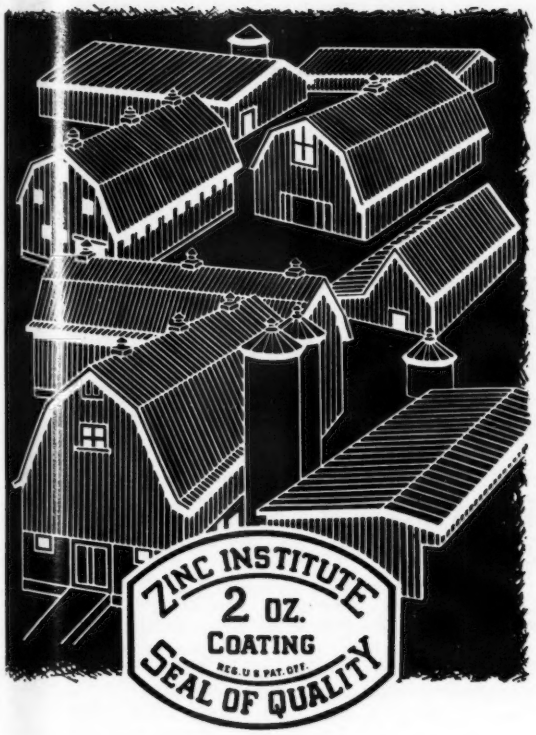

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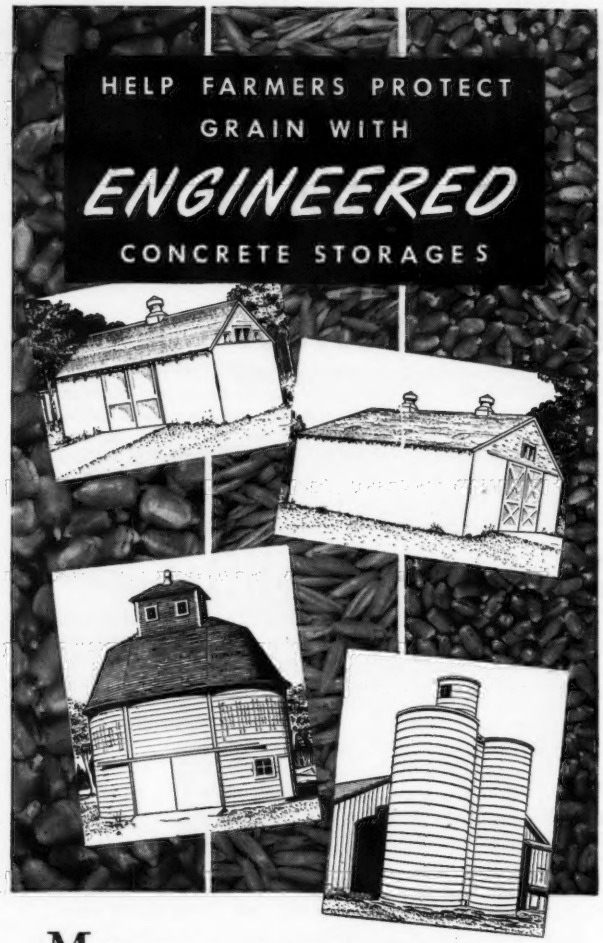

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Rainfall and Runoff Studies

(Continued from page 518)

It has been said that the Great Plains can expect at least one gully washer and one drought each year. In the past 55 yr Hastings has received as much as 18.39 in and as little as 0.05 in in a 2-mo period. In the past 12 yr, yearly rainfall has varied from 13.0 to 31.8 in on the project. In 1949 we had 13.1 in in May and June, and only 0.16 in the last 82 days of the year. Individual storms may vary considerably in short distances. In a storm on June 5, 1942 the rainfall varied from 0.50 to 2.30 in in a distance of less than 2 mi. Other storms have varied up to 1.6 in in the 6 sq mi of the experimental area. The extreme variability in rainfall conditions constitutes a serious problem to agriculture in the Great Plains.

The water table in the experimental area lies at a depth of 40 to 120 ft. Little if any water reaches the ground water through the deep loessial deposits, and no accretion to stream flow from watersheds in the area comes from the ground water. This is significant, since all precipitation can be accounted for as evaporation, transpiration, runoff, or soil moisture.

Intensity and amount of rainfall are the origin of runoff, but many factors intercede before rainfall finds its way to channels as runoff and proceeds downstream. It is known now that a coefficient applied to rainfall does not determine runoff. Cover, composition of the soil, permeability, drainage density, depth of soil, tillage, land use, erosion, topography, channel storage and seasonal changes are a few of the factors.

Experimental Set-up. The Central Great Plains Experimental Watershed is operated under five distinct working plans, which have been approved by the director of the Nebraska Agricultural Experiment Station and Soil Conservation Service officials and technicians interested in and responsible for the research program. Data collected under working plan No. 1, "The Effect of Land-Use and Soil-Conservation Practices on Runoff from Small Watersheds", and working plan No. 3, "Characteristics of Flood Runoff from Agricultural Areas of Different Sizes", are the main sources of information for this paper.

In setting up working plan No. 1, to study the effect of land-use and soil-conservation practices on runoff, we attempted to keep comparable as many factors as possible, except land use, which was the purpose of the experiment. Twenty-one cultivated watersheds and three native grass watersheds of about 4 acres each were established in 1939-41. They are farmed as fields with duplicate and triplicate areas in a corn, oats, and wheat rotation, planted on the contour, in straight rows and on the contour with subsurface tillage. These areas were selected as nearly as possible on the same soil, with approximately the same slope, shape and size. Theoretically they are the same except for the land use.

Maximum Peak Rates of Runoff on Corn. Maximum peak rates of runoff during 1946 occurred on August 7, when a rain of 1.76 in fell in 36 min with a maximum intensity of 7.08 iph (inches per hour) for a 5-min *(Continued on page 522)*

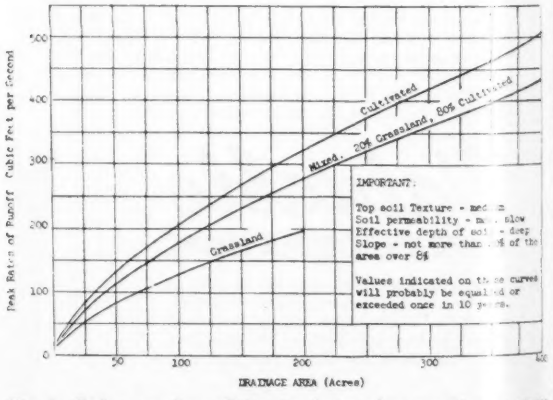

Fig. 2 Peak rates of runoff for the design of conservation structures in the Central Great Plains of Nebraska and Kansas

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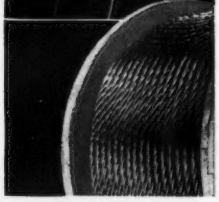

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Rainfall and Runoff Studies

(Continued from page 520)

period. This storm exceeded the 5, 10 and 15-min 10-yr frequency expectancies, according to Yarnell's data (1)*. The corn at this time was about 6 ft high. Average maximum peak rates of runoff from this storm were:

Corn, straight-row listed	5.79 iph
Corn, contour listed	2.98 iph
Corn, subsurface tilled	2.93 iph

On June 12, 1947, a rain of 2.09 in fell in 7½ r with a maximum intensity of about 3.00 iph for a 5-min p iod. At the time of this storm the corn was about 5 in h. The maximum peak rate of runoff was 1.68 iph from corn straight-row listed. Contour listing and subsurface tillage re ced this by better than two-thirds.

On July 18, 1948, a rain of 0.93 in fell in 16 m with a maximum intensity of 6 iph for a 5-min period. The orn was about 3 ft high. The average maximum peak rates f runoff was 3.28 iph from corn straight-row listed. Conto listing reduced this by one-half and subsurface tillage wit residue by almost two-thirds.

On July 13, 1949, a rain of 0.78 in fell in 33 mi with a maximum intensity of about 3 iph for a 5-min per d. The corn was about 2 ft high. The average maximum peak rate of runoff was 3.30 iph from corn straight row. Contour listing reduced this by three-fourths and subsurface tillage by more than one-half. The foregoing are shown graphically in Fig. 1.

TABLE 1 AVERAGE MAXIMUM PEAK RATES OF RUNOFF FROM SMALL GRAIN WATERSHEDS FOR SELECTED STORMS, 1946-1949

Date	Straight row, iph	Contoured, iph	Subtilled, iph	Remarks
Sept. 5, 1946	2.72	2.52	1.22	Stubble
June 12, 1947	1.49	0.60	1.06	Grain about 10 in high
July 18, 1948	0.66	0.54	0.44	Grain being harvested
May 5, 1949	3.11	2.23	2.78	Grain about 3 in high

These data show a trend that land use affects peak rates of runoff and that conservation practices will reduce peak rates of runoff. In the design of a structure for a small agricultural area these factors should be taken into consideration, or at least used as a safety factor if there is some assurance that a conservation program will be followed.

As a matter of interest, during the period 1946-1949, corn yields have averaged about 5 bu more per acre on the contour and subtilled land than on the straight-row land. Yields of small grains show that contoured oats yields were about 3 bu more per acre and subtilled oats about 1 bu more per acre than straight-row oats.

Runoff From Various Sized Areas. Under working plan No. 3, "Characteristics of Flood Runoff from Agricultural Areas of Different Sizes", four gaging stations were established in 1939-1940 on mixed cover watersheds. The drainage areas of these watersheds are 411 acres, 481 acres, 2,086 acres and 3,490 acres. Watershed W-3 of 481 acres and watershed W-5 of 411 acres were selected as comparable. These two stations have been put through a 7-yr calibration period to determine any differences in runoff under prevailing land-use practices. The data have been analyzed by W. D. Potter(2) and it has been found that the runoff from these two areas was similar both in peak rates and in total runoff per acre. In May, 1947 steps were taken to place watershed W-5 under a conservation program so that the actual runoff records on a larger sized area can be compared against a similar area which has been untreated.

Analysis of Data. Several years additional records are needed before an analysis can be made of the data to determine the effects of runoff from conservation practices. However, an analysis of peak rates of runoff has been made from information collected at this station, U. S. Weather Bureau records of precipitation and U. S. *(Continued on page 524)*

* Numbers in parentheses refer to the appended references.

Caterpillar Diesel D8 Tractor with No. 80 Scraper leveling 65 acres for an alfalfa field in California. The D8 uses Fafnir Ball Bearings in applications such as fan, governor, starting engine and main engine transmissions, steering clutch, final drive, electric starter and power takeoff.

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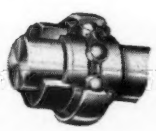
EVERYBODY KNOWS Caterpillar because they've seen these bright yellow machines everywhere literally making mole hills out of mountains and level fields out of mole hills. Caterpillars make the most of their terrific power through generous use of Fafnir Ball Bearings.

Caterpillar knows Fafnir Ball Bearings from years and years of satisfying experience under every conceivable punishing condition.

Most of all, what Caterpillar and other leading tractor and implement makers value about Fafnir is something more than just ball bearings. It's an attitude and an aptitude . . . a way of looking at ball bearings from where you're sitting . . . an aptitude for doing just what you'd like done about it, gained from solving the bearing problems of not just one or two industries but of all industries. The Fafnir Bearing Company, New Britain, Connecticut.

TYPICAL FAFNIR BALL BEARINGS USED IN FARM EQUIPMENT.

Standard Radial Ball Bearings



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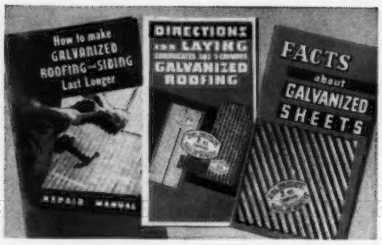
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Rainfall and Runoff Studies

(Continued from page 522)

Geological Survey records and other data which are applicable in this area for areas under prevailing land-use practices. It is recognized that the short periods of record, especially on small agricultural areas in the Great Plains, are insufficient. However, the immediate need for information that would help in the design of structures has led us to make some preliminary analysis. Rainfall during the 8 yr of record were representative of the long-time record of rainfall, both in intensity and total amounts. Peak rates of runoff for this period were then extended by probability computations to a 10 and 25-yr expectancy. Fig. 2 shows the peak rates of runoff which will probably be equalled or exceeded once in 10 yr.(3)

SUMMARY

This hydrological experimental watershed was established to provide information on peak rates of runoff and total runoff for the economical design of conservation structures.

Variations in rainfall—floods and droughts in the same year—and the many factors which affect intake of water before rainfall finds its way into channels and proceeds downstream are some of the problems encountered in predicting expected peak rates of runoff. The data show that conservation practices tend to reduce peak rates of runoff.

Studies are being made on small watersheds in different land-use practice and on larger mixed-cover watersheds to determine the effect of conservation practices. However, the periods of record are short and no analysis has been made of these data to date. An analysis of the data has been made on peak rates of runoff under prevailing land-use practices.

Longer periods of record are needed before conclusive results are obtained, but it is felt that each year's data adds to the confidence that can be placed in the records.

REFERENCES

1 Yarnell, D. L.: Rainfall Intensity-Frequency Data. U. S. Dept. of Agr. Misc. Pub. 204.

2 Potter, W. D.: Analytical Procedures for Determining the Effect of Land Use on Surface Runoff. AGRICULTURAL ENGINEERING 29: 64-73 (1948).

3 Allis, John A.: Rates of Runoff for the Design of Conservation Structures in the Central Great Plains of Nebraska and Kansas. USDA SCS-TP-69.

Good Products

(Continued from page 495)

It is a means of improving, from a quality-value standpoint, the products the farmer delivers or starts on their way to the ultimate consumer. It helps the crop plant and farm animal to produce a higher proportion of desirable food, fiber, or other organic products; and helps the farmer to conserve these values in harvesting, handling, preliminary processing, storage, and delivery at reduced cost per unit.

In other words, utilization of agricultural engineers and agricultural engineering is good business for farmers, for many of the industries serving agriculture, for the industries processing farm products, and for the ultimate consumers of farm products. They can be expected to go on improving farm products and products used primarily by farmers.

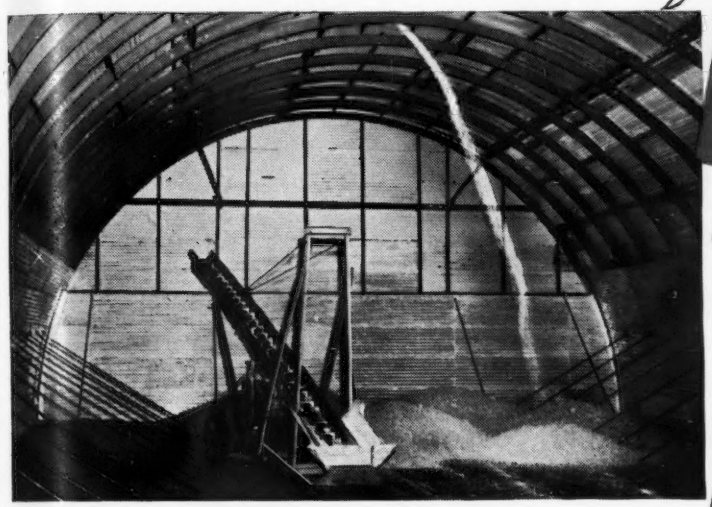
Engineering Service in Civil Defense

AN enemy attack with atomic weapons on a large American city might well present emergency engineering problems of a magnitude not previously experienced in the United States. Essential services such as communications, power, and water supply would be disrupted and debris in thousands of tons would fill streets and highways, blocking access to damaged areas.

To cope with these problems, each local civil-defense organization should include an engineering service responsible for planning the use of, and coordinating and directing in action, all personnel, equipment and material assigned to engineering and construction work during the emergency period immediately following a disaster. Many of these activities are primary responsibilities of the engineering service. Others are in the nature of assistance essential to other civil-defense services in carrying out their assignments. There should be an engineering service representative on the staff of the state civil defense director to assist local organizations in planning and formalizing mutual aid and mobile-support assistance. From "United States Civil Defense".

DOUBLE USE OF QUONSETS ADDS TO FARM INCOME

Versatile, all-steel buildings safeguard crops—serve as farm shelters the year around



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Stran-Steel and Quonset Reg. U.S. Pat. Off.

Quonsets for crop storage! Here is one way to add to farm income. Use Quonsets! Hold your crops for highest prices! Strong, sturdy, durable, all-steel Quonsets provide maximum protection for stored crops at a low cost per bushel . . . provide the utmost in usable space. Quonsets can easily be partitioned to store more than one crop at once.

STRAN-STEEL QUONSETS

- adaptable
- permanent
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Your best buy in farm buildings

Quonsets for equipment storage! You have no worries about equipment when it is sheltered from wind and weather in a Quonset! The versatile fire-resistant Quonset is the best answer to the general equipment storage problem during off seasons . . . eliminates the need for an extra storage building.

see your dealer today!

Quonset 32 Quonset 24 Quonset 40

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BUT THEY'RE ALL Knoedler

Pat. No. 2432534 other patent pending

FLOW-TING SEATS

MOST ADAPTABLE SEAT IN THE INDUSTRY!

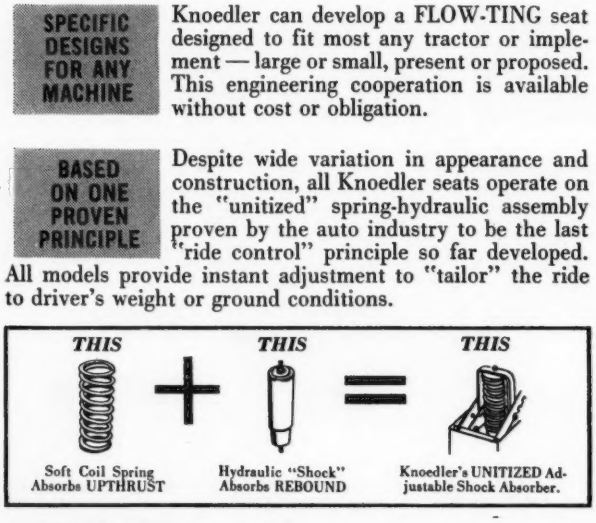
15 versions of the famous FLOW-TING Spring Hydraulic Seat are now available to fit 95% of all tractor makes and models—as well as many self-propelled combines and earth-moving units.

SPECIFIC DESIGNS FOR ANY MACHINE

Knoedler can develop a FLOW-TING seat designed to fit most any tractor or implement — large or small, present or proposed. This engineering cooperation is available without cost or obligation.

BASED ON ONE PROVEN PRINCIPLE

Despite wide variation in appearance and construction, all Knoedler seats operate on the "unitized" spring-hydraulic assembly proven by the auto industry to be the last "ride control" principle so far developed. All models provide instant adjustment to "tailor" the ride to driver's weight or ground conditions.



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It takes *both* springs and hydraulic shock absorber action to provide effective ride control. The auto industry proved that years ago. Let us show you how the Knoedler seat can be adapted to any machine where an even "floating" ride—free from shock, "see-saw" or dumping action — can contribute to operator safety & health.

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NEWS SECTION

A.S.A.E. Meetings Calendar

October 14 — GEORGIA SECTION, Barrow Hall, University of Georgia, Athens.

October 19 and 20 — PACIFIC NORTHWEST SECTION, Commercial Hotel, Yakima, Wash.

October 20 and 21 — PENNSYLVANIA SECTION, Brunswick Hotel, Lancaster, Pa.

October 27 and 28—ALABAMA SECTION, Agricultural Engineering Bldg., Alabama Polytechnic Institute, Auburn.

November 8—IOWA-ILLINOIS SECTION, John Deere Waterloo Tractor Works, Waterloo, Iowa.

November 18—MICHIGAN SECTION, Agricultural Engineering Bldg., Michigan State College, East Lansing.

December 18-20 — WINTER MEETING, The Stevens, Chicago, Ill.

January 26 and 27—PACIFIC COAST SECTION, Calif. Fruit Growers Exchange Bldg., 707 W. 5th St., Los Angeles, Calif.

February 5-7 — SOUTHEAST SECTION, Peabody Hotel, Memphis, Tenn.

March 23 and 24—SOUTHWEST SECTION, Texarkana, Tex.

June 18-20 — ANNUAL MEETING, Rice Hotel, Houston, Tex.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to A.S.A.E., St. Joseph, Michigan

ASAE Pacific Northwest Section Meets October 18 to 21

THE yearly meeting of the Pacific Northwest Section of the American Society of Agricultural Engineers will be held October 18 to 21 at the Commercial Hotel, Yakima, Wash. The general theme of the meeting will be on reclamation.

The meeting will open Thursday forenoon, October 19, with an address by F. C. Fenton, president of ASAE. This will be followed by a paper on instrumentation for agriculture by W. H. Kliever, Minneapolis-Honeywell Regulator Co., and one on farm machinery observations in Europe, Asia and Africa by R. B. Gray, U.S. Department of Agriculture. Two other papers for this session are one on the historical background of reclamation by Dr. O. W. Israelson, Utah State Agricultural College, and another on reconnaissance and preliminary planning for reclamation by Alden Copeland, U.S. Soil Conservation Service.

The afternoon program will open with a Section business meeting which will be followed by a general program of particular interest to agricultural engineering students.

The evening of October 19 will be devoted to four concurrent round tables covering power and machinery, rural electrification, soil and water, and farm structures.

The program for October 20 will open with a paper on determining proper irrigation methods by K. O. Kohler, U.S. Soil Conservation Service, followed by a paper on planning the farm irrigation system by Del Shockley, also of SCS. L. R. Swarner of the U.S. Bureau of Reclamation will discuss the efficient use of irrigation water. The subject of tillage machinery will be discussed by Milo Hoisbeen of Ephrata, Wash., and crop handling machinery by Emil Madison, Pacific Supply Cooperative.

The afternoon program will be devoted to an illustrated talk on farm structures and reclamation by Art Cagle of Washington State College, a paper on water rights from ground and streams by Charles Bartholet, a hydraulic engineer, and a paper on irrigation as viewed by an electrical engineer by Aldert Molenaar of Washington State College.

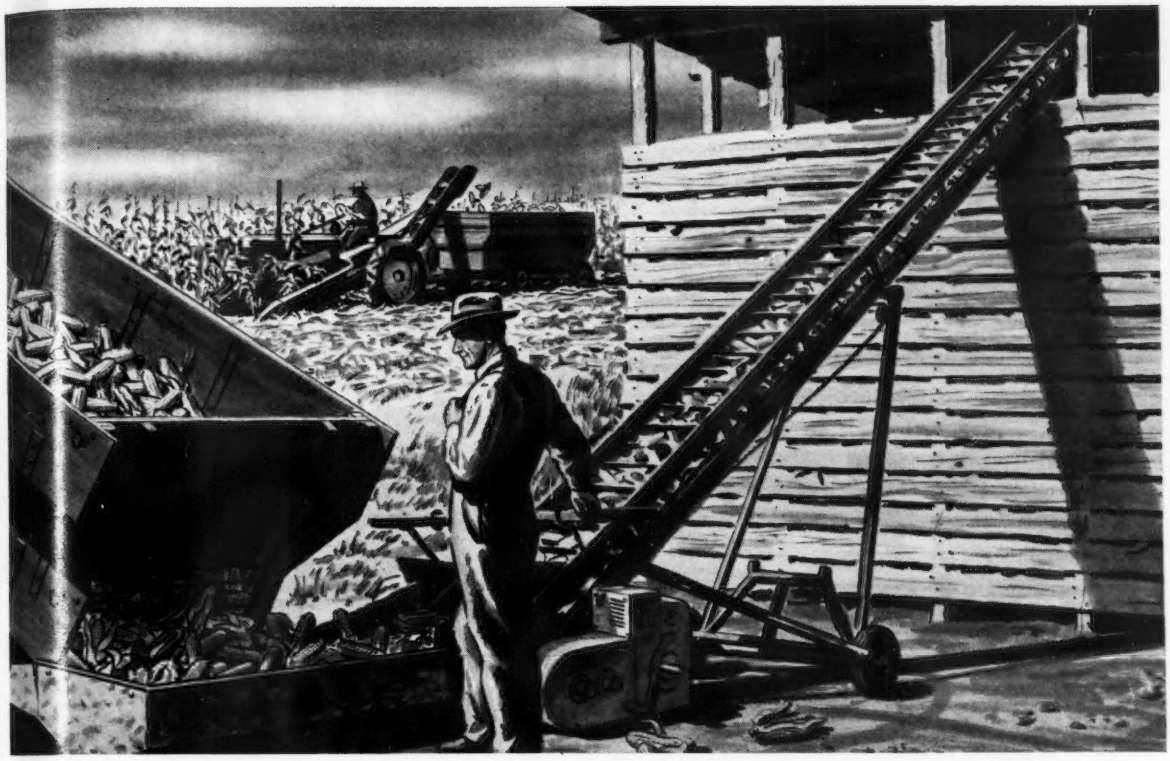
The Northwest Section dinner will be held in the evening of October 20 with Congressman Hal Holmes of Ellensburg, Wash., as the speaker.

Copies of the program and other information regarding the meeting will be sent on request to F. G. Mackaness, Section Secretary, Portland General Electric Co., 621 S. W. Alder Street, Portland 5, Ore., or to ASAE headquarters, St. Joseph, Michigan.

ASAE Iowa-Illinois Section Meets Nov. 8

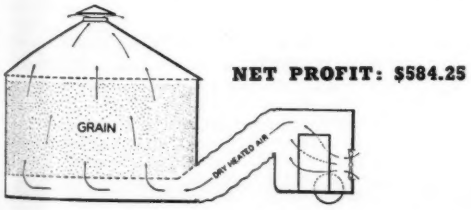
THE Iowa-Illinois Section of the American Society of Agricultural Engineers will hold its first meeting of the current meeting season at Waterloo, Iowa, on November 8. The Section is holding this meeting at the invitation of the John Deere Waterloo Tractor Works, and it is being held jointly with two other societies, the Waterloo Technical Society and the Central Iowa Section of ASME. In addition to a program of papers, a feature of the meeting will be factory tours and special engineering exhibits.

(Continued on page 528)



What's wrong with this picture?

Equipment manufacturers know the answer at a glance. . . . This farmer has used modern machinery to harvest his corn because he knows it saves time, labor and money. Yet, after months of raising the crop and carefully harvesting it, he stores it in the old corncrib—much like the one his forefathers used a hundred years ago. A steel storage bin and mechanical dryer would give him a greater profit.



NET PROFIT: $584.25

Agricultural engineers cite this true story to show the worth of modern storage equipment. Last April, a farmer near Lafayette, Indiana, was offered $2421 for 2550 bushels of 21% moisture content corn. He placed this corn in a steel bin fitted with a false floor, and dried it with a portable crop dryer. Moisture content was reduced to 12.8%. The same elevator that had originally quoted on the wet corn bought the dry corn for $3190.75. Total cost of drying, including a 10% depreciation charge for the equipment, was $185.50. Net profit was $584.25—the profit would have been still greater if depreciation had been spread over several drying operations (wheat, oats, hay, etc.).

You well know that storing crops in modern steel bins and drying them mechanically cuts losses from spoilage, rats and other hazards. And you may say with assurance that steel storage bins made of Armco ZINCGRIP Steel, and dryers with combustion chambers made of Armco Stainless or Armco ALUMINIZED Steel, not only protect crops but stand up longer in this severe service.

Point out that Armco ZINCGRIP is a Special-Purpose Steel that gives complete rust protection, and Armco ALUMINIZED and Stainless both resist heat and corrosion damage and cut fuel costs. Bins and dryers made of these *extra*-quality steels will make the farmer more money and save him money.

50th ANNIVERSARY SPECIAL PURPOSE STEELS

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Alabama Section Fall Meeting

THE opening gun of the 1950-51 meeting season for the Alabama Section of the American Society of Agricultural Engineers will be heard in Auburn on October 27, and for all who attend, they will sound off again the following day during the clash between Tulane and Auburn in their annual football classic.

A splendid program has been arranged for the Section meeting consisting of such topics and features as the functions of a farm machinery company trainee program, beef cattle and machinery, swine production and housing, the relation of electric power to agricultural engineering, agricultural engineering as a general education, and a tour of the agricultural engineering farm. Also scheduled is a fish fry and luncheon to be held jointly with the Alabama Student Branch of ASAE. ASAE members who are interested in attending and desire hotel reservations or football tickets are requested to write to Arthur W. Cooper, agricultural engineering bldg., Alabama Polytechnic Institute, Auburn.

CUT SERVICE COSTS with LISLE Magnetic DRAIN PLUGS

Here's the low-cost way to reduce manufacturers' service problems. Use Lisle Magnetic Plugs instead of ordinary drain plugs in farm equipment that has to operate long gruelling hours. Lisle Plugs TRAP abrasive metal particles that flake off moving parts during normal wear. They HOLD this "Wild Metal" before it can circulate in the lubricant and cause damage or failure in gears, bearings, valves or pumps. No change in design is necessary. Specify Lisle Magnetic Plugs and cut service costs.

WRITE on your letterhead. Free catalog and sample plug for testing will be mailed without obligation. State size, style plug desired.

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ASAE Southwest Section Meets March 23-24

IT has been announced that the Southwest Section of the American Society of Agricultural Engineers will hold its 1951 meeting at Texarkana, Texas, on Friday and Saturday, March 23 and 24, 1951.

Engineering on Farm Safety Program

"ENGINEERING for Safety," by E. W. Tanquary, engineer, farm implement division, International Harvester Co., will be a featured talk at one of the farm safety sessions of the National Safety Congress and Exposition at Chicago, October 16-20.

Other agricultural engineering subjects and speakers on the farm safety sessions, October 17 and 18, include "Rural Fire Safety Progress," by Geo. Amundson, extension agricultural engineer, Michigan State College; "Individualized Farm Safety Campaigns," by W. E. Stuckey, farm safety specialist, Ohio Industrial Commission; and "Country-Wide Farm Safety Clinics," by Norval J. Wardle, assistant professor of agricultural engineering, Iowa State College. The farm safety sessions will be held at the LaSalle Hotel.

For the over-all safety program of the Congress, the National Safety Council has scheduled 600 program participants for more than 200 sessions at five hotels, for an expected attendance of 12,000 safety-minded persons.

Pennsylvania Section Program

THE Pennsylvania Section of ASAE will meet at the Brunswick Hotel in Lancaster for their annual meeting on October 20 and 21. The entire first day will be devoted to tours to prominent farms and industrial plants. Stops on the morning tour will include a barn cleaner operating in three parallel gutters, a hay finisher, farm shop, a conservation project embodying terracing, farm ponds and contour strips, an automatic poultry feeder in a three-story house operated from one power unit, and a visit to the Safe Harbor water power plant. The agenda for the afternoon begins with a plant tour of the New Holland Machine Co., followed by an irrigation system and vegetable washer demonstration, and a visit to an ultra-modern milking parlor with pen stable.

The annual dinner of the Pennsylvania Section will feature Ralph Wennblorn, crops and machinery editor of the Farm Journal, as speaker. Following the dinner, discussion groups on research results in forage handling methods and equipment, farm structures as they affect ventilation, and recent developments in crop drying will conclude the first day's program.

Presentation of papers on the development of the New Holland wire tie baler by A. M. Best, New Holland Machine Co.; developments in farm buildings by D. C. Sprague, Pennsylvania State College; and pasture irrigation in Pennsylvania, by W. J. Liddell, Sunset Engineering Co. will comprise the second day's program. A Section business meeting will complete the meeting.

SCSA Meets in Detroit

THE Soil Conservation Society of America will hold its fifth annual meeting at the Statler Hotel, Detroit, Mich., October 26-28.

Distinguished speakers on the program include Dr. Irving Langmuir, on rainfall control and Charles F. Kettering, on "looking ahead."

ASAE members participating in the program include Fred A. Wirt, past-president of ASAE, and member of the council of the Soil Conservation Society, who will preside at one of the sessions; W. W. McLaughlin, who will preside over a panel on water management; George D. Clyde, scheduled for contributions on what determines the value of water and on artificially changing ground water aquifers; I. D. Wood, on looking ahead in irrigation; George D. Scarseth, on building soil structure with deep-rooted legumes; and C. S. Slater, who will talk on temperature troubles in soil and water conservation.

In general, the program will feature attention to water resources, soil and vegetation factors, farm practices, and the social and economic significance of conservation, with major emphasis on water and its control.

(News continued on page 530)

Cut Chore-Time Drudgery

UP TO 3 HOURS A DAY

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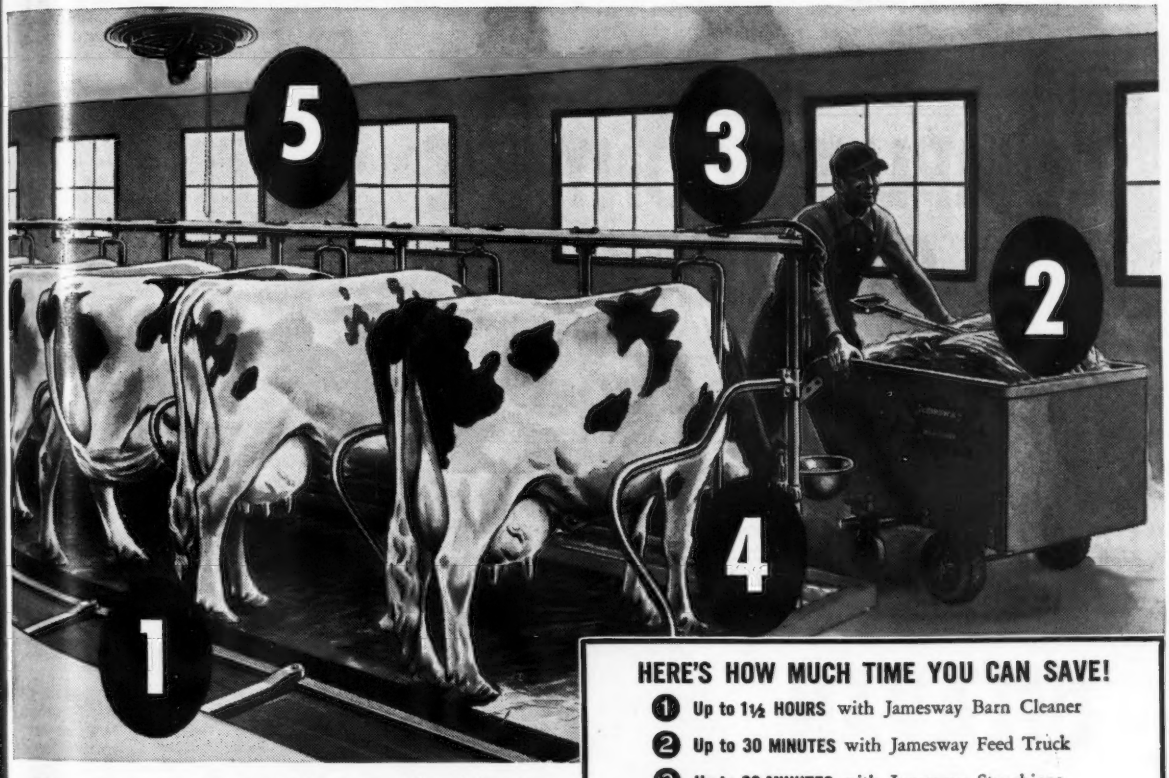

HERE'S HOW MUCH TIME YOU CAN SAVE!

1. **Up to 1½ HOURS** with Jamesway Barn Cleaner
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4. **Up to 30 MINUTES** with Jamesway Water Cups
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Yes, now you can save up to 3 hours every day of the year with Jamesway's modern, time-saving equipment. It takes the hard, back-breaking work out of your chores. Makes it easier for you to give your herd extra attention. Helps you produce more milk, cleaner milk . . . increase your dairy profits.

Stop in and see your Jamesway Dealer the next time you are in town. Find out how easy it is to modernize your barn with Jamesway plans and equipment. Mail coupon below for free time-saving folders.

See the Sensational NEW Jamesway Barn Cleaner with Patented Shuttle Action

New, sensational, pull-push barn cleaner frees you of daily barn drudgery! No more scooping, scraping . . . heavy lifting! With the Jamesway Barn Cleaner, you just flip the switch!

It cleans your barn cleaner. Amazing new shuttle action whisks manure from gutter *straight* to spreader. No endless gutter chains to wear out or break. Cleaning paddles fold against steel gutter bar . . . leave gutter clear when not in use. Ask your dealer for a free demonstration. You'll see why the Jamesway Barn Cleaner is the leader.

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It's *easy* to install a Jamesway Barn Cleaner. It fits any gutter — any barn. No indoor pits or cross-gutters to collect filth. Shielded drive unit sets outside. No wasted stall space.

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Dairy Barn ☐ Hog House ☐ Poultry House ☐

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World's Largest Makers of TIME-SAVING EQUIPMENT for Cows, Hens, Hogs

Hydraulics Conference Program

AGRICULTURAL hydraulics are scheduled for attention in a half-day session of the sixth annual National Conference on Industrial Hydraulics to be held in Chicago, October 18 and 19, at the Sherman Hotel.

Wayne H. Worthington, director of engineering research, John Deere Waterloo Tractor Works, will preside at the session on agricultural hydraulics, which is to be held Thursday afternoon, October 19. Two other members of the American Society of Agricultural Engineers will be the contributors to the program of this session. One is J. F. Ziskal, engineer, farm tractor engineering division, tractor works, International Harvester Co. His subject will be "Utility of Hydraulic Power in Farming with Wheel-Type Tractors." The other is Frank P. Hanson, agricultural engineer, Caterpillar Tractor Co., whose subject is "Utility of Hydraulic Power in Farming with Track-Laying Type Tractors."

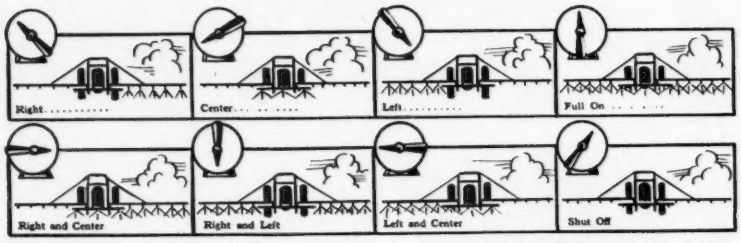
This two-day technical conference is devoted to serving all engineers in the field of industrial hydraulics through cross circulation of ideas and presentation of technical papers by authoritative speakers. It is sponsored by the Armour Research Foundation and the Graduate School of the Illinois Institute of Technology, with the cooperation of eight technical societies, including the American Society of Agricultural Engineers. The official ASAE representative to the conference is Milton J. Taup, district manager, Vickers, Inc.

In addition to the session on agricultural hydraulics there will be a general session and others on aeronautical hydraulics, centrifugal pumps, chemical engineering, hydraulic presses, civil engineering hydraulics, hose and fittings, refinery hydraulics, and control of surges.

ASAE Southeast Section Meets Feb. 5 to 7

ANNOUNCEMENT is made of the next meeting of the Southeast Section of the American Society of Agricultural Engineers at the Peabody Hotel, Memphis, Tenn., February 5 to 7, 1951. The meeting will be held, as it has in recent years, in conjunction with the annual convention of the Association of Southern Agricultural Workers.

COMPLETE CONTROL OF SPRAY



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Electrification Conference

THE Fifth National Farm Electrification Conference has been scheduled for October 18-20 at the Melbourne Hotel, St. Louis, Mo.

"Farm Electrification — What are our problems and what should we do about them?" has been announced as the conference theme. Problems in the particular fields of farm applications, farm home uses, electric heating, water supply, research, testing and proving new products, education and promotion, distribution and service, and retailing are scheduled for attention.

A. H. Hemker, manager, farm industry division, General Electric Co., is program chairman for the Conference. Orval C. French, Geo. W. Kable, T. E. Hienton, R. R. McBeth, and P. T. Montfort include the agricultural engineers (members of ASAE) who are scheduled to contribute to the Conference program.

Personals

J. P. Fairbank, for many years agricultural engineering extension specialist, University of California, and more recently on the agricultural engineering experiment station staff at Davis, was recently appointed a state leader of the California Agricultural Extension Service, with headquarters at Berkeley.

David Meeker has been advanced from his position as director of education, Dearborn Motors Corp., to Pacific Coast sales manager. He will be located at the Company's Pacific Coast headquarters at Oakland, Calif.

Fred W. Roth, graduate assistant in the agricultural engineering department at Michigan State College, recently received his master's degree there and has accepted a position as assistant professor in the agricultural engineering department at the University of Maine, effective about October 1.

Necrology

GEORGE E. ZERFOSS passed away August 28, 1950, according to brief information received from one of his associates. He was 53 years of age. A native of Bedford, Kentucky, he earned his bachelor's degree in mechanical engineering at the University of Kentucky in 1921, and his master's degree in agricultural engineering at Virginia Polytechnic Institute in 1942. Following early professional experience with the Carrier Engineering Corp. and the York Ice Machinery Corp., he entered public service work with the U.S. Forest Service in 1934, transferred to the U.S. Bureau of Agricultural Engineering in 1935, and again transferred in 1936 to the Tennessee Valley Authority, with which he continued until his passing, in research on heating, ventilating fans, crop drying, and related subjects. He had been a member of ASAE since 1946.

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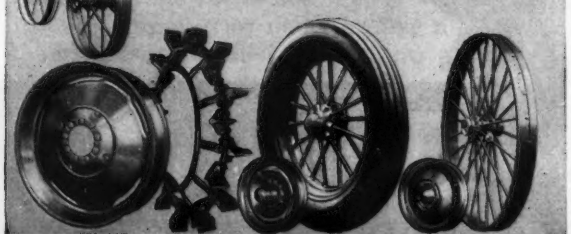

ELECTRIC WHEEL CO., 2908 Pine, Quincy, Ill.

Use of Electric Lamps and Traps in Corn Borer Control

(Continued from page 505)

difference was noted between lamp spacing of 100 and 200 ft. In this test very little circling of the moths about the lamps was noted and there was no build-up of infestation immediately in front of the lamps. The electrocuter-type traps functioned satisfactorily in killing a high percentage of the moths attracted.

For the second generation flight the traps were moved to a late-planted 100-acre sweet corn field. Four traps placed 200 ft apart were used across one section of the field 52 rows (173 ft) from the south edge.

All lamps were of the 360 BL type but on two of the traps a single 30-w lamp was used on each side and on the other two traps, two 30-w lamps were used on each side.

There was an extremely heavy flight of moths in this field: the average population over the field was 344 borers per 100 ears. For the first week of operation, while the moth population was comparatively light, the traps operated satisfactorily and a few egg masses could be found on the irradiated plants. However, after the moth population had built up to a heavy flight, the grids of the traps became clogged after a few minutes of operation and became ineffective. Moths then settled around the traps and deposited large numbers of eggs. Consequently, little, if any, control was effected.

Trap Design. It appears that the ¼-in spacing between grid wires used is too close to prevent clogging in the grids by the corn borer moth. Some preliminary work at Ames in 1949 indicated that ⅜-in spacing was too large. Consequently, ⅜-in or ½-in grid spacing may be assumed to be more satisfactory.

The 3500-v grid potential is also unsatisfactory during heavy moth flights as the grids will not clean themselves. Tests made in Iowa and Indiana last year indicated that higher voltages (up to 7500-v) would be more satisfactory. For human safety the maximum current should not be over 15 ma (5). It has also been suggested that a mechanical means of vibrating the electrocuter panel may be used to keep the insects from clinging.

Besides the single flat panels used, three other modifications were tested. One consisted of four panels forming a rectangle (Fig. 6). A second with a flat vertical panel with two protruding lower panels set at an angle of 135 deg from the vertical sloping downward (Fig. 7); and a third consisting of three vertical panels spaced at 120-deg intervals in the horizontal plane (Fig. 8). The latter type proved most effective of the three described. It has not been tested as yet against the single flat panels, however. The panel with the lower protusions seemingly had advantages for larger insects as it was possible for the insects to receive a second shock as they fell from the vertical panel.

Other Insects Attracted. Among the economic insects were the adults of the tomato hornworm (*Protoparce quinquemaculata Haw.),* the tobacco hornworm *(P. sexta Johan.)* and the corn ear worm (*Heliothis armigera Hbn.*), which were attracted in great numbers to sources radiating in the near ultraviolet.

REFERENCES

1 Beck, E. W.: Estimates of Damage by the European Corn Borer to Field Corn in the United States in 1949. USDA, BEPQ Insect Pest Survey. Special Sup., no. 2. (February, 1950).

2 Ficht, G. A. and Hienton, T. E.: Studies on the Flight of European Corn Borer Moths to Light Traps - A Progress Report. *Journal of Economic Entomology,* vol. 32, no. 4. (August, 1939).

3 Baker, W. A. and Bradley, W. G.: The European Corn Borer: Its Present Status and Methods of Control. USDA Farmers' Bulletin no. 1548. (Issued October, 1937; revised September, 1948).

4 Ficht, G. A., Hienton, T. E., and Fore, J. M.: The Use of Electric Light Traps in the Control of the European Corn Borer. AGRICULTURAL ENGINEERING, vol. 21, no. 3 (March, 1940).

5 Dalziel, C. F.: Danger of Electrical Shock. *Electrical West,* vol 80, no. 4 (April, 1938).

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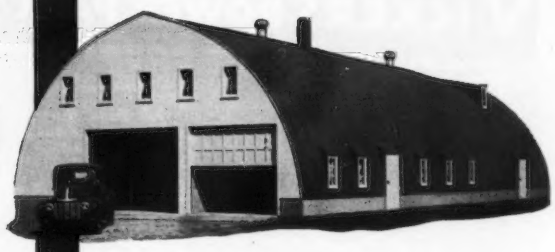

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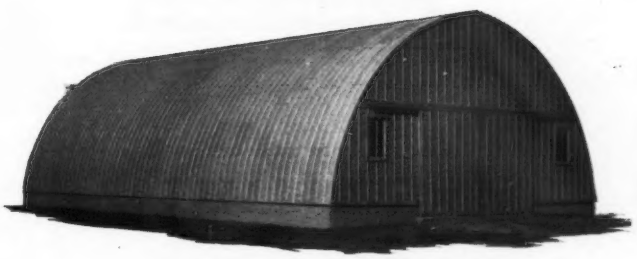

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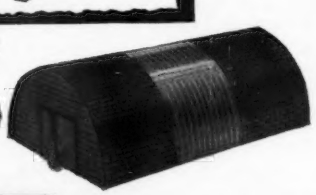

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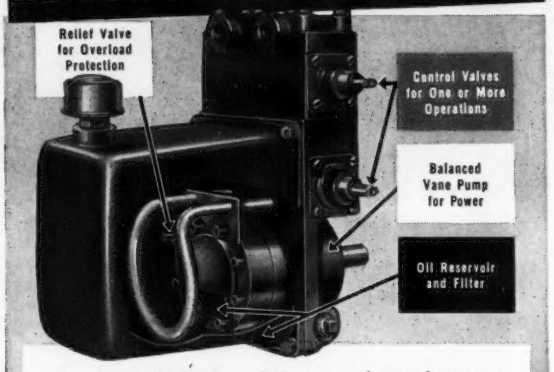
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Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Adair, W. M. Jr.—Sales engr., Willamette Tractor Co., Albany, Ore.

Asher, Andrew J.—St. Joseph, Ill.

Biddle, Reason H.—Mgr., Owensville Lumber & Supply Co., Owensville, Ind.

Cameron, Alex R.—General mgr., W. R. Ames Co. of Florida, Tampa 5, Fla. (Mail) 1102 Genesee St.

Christensen, Harvey J.—Trainee, Caterpillar Tractor Co. (Mail) 120 Linden St., East Peoria, Ill.

Doughty, Robert E.—RR 3, Bay & Capitola Ave., Santa Cruz, Calif.

Eckert, Edwin J.—Trainee, Caterpillar Tractor Co. (Mail) 124 Craig Rd., Marquette Heights, Pekin, Ill.

Fletcher, William J.—Rural sales rep., Public Service Co. of Northern Illinois. (Mail) c/o Blanton Farm, RR 2, Crystal Lake, Ill.

Follett, Norris M.—Sales engr., Sunset Engineering Co. (Mail) 49 Grove St., Naugatuck, Conn.

Foss, Ray E.—Sales mgr., Shepard Irrigation Equipment Co., Ellington, Conn.

Hawkins, John M.—1207 Central St., Lafayette, Ind.

Heller, L. W.—Jr. engr., John Deere Ottumwa Works. (Mail) 324 N. Aldrich, Geneseo, Ill.

Jennings, Norman R.—Asst. in agr. engr., Cornell University, Ithaca, N. Y.

Libby, Carl F.—Agr. engr., Northeast Agricultural Engineering Service, Hampden, Mass.

Liljedahl, Louis A.—Agr. engr., Permco Mfg. Co., Peru, Nebr.

Little, Louis P.—Salesman, Chenango Tractor & Equipment Co. (Mail) RR 1, Afton, N. Y.

Morgan, Dean M.—Asst. service supervisor, International Harvester Co. (Mail) 4212 Douglas Ave., Des Moines, Iowa.

Shirer, James H.—Salesman, Farmers Supply Co., Inc., Conway, S. C. (Mail) P. O. Box 507

Staats, Louis T., Jr.—Salesman, Newark Farm & Home Supply, Newark, Del. (Mail) P. O. Box 448

Veasey, Harry W., Jr.—Sales engr., W. R. Ames Co. of Florida, 3905 E. Broadway, Tampa 5, Fla.

Cross, Otis E.—Asst. prof. of agr. eng., University of Georgia, Athens, Ga. (Junior Member to Member)

Jaska, Robert C.—Instructor in agr. eng., A. & M. College of Texas, College Station, Tex. (Junior Member to Member)

Ota, Hajime—Asst. agr. engr., USDA. (Mail) P. O. Box 222, Redwood Falls, Minn. (Junior Member to Member)

Weber, J. Arthur—Res. asst. in agr. eng., University of Illinois. (Mail) Outlook Sanatorium, Urbana, Ill. (Junior Member to Member)

Corn Picker Stalk Shredder

(Continued from page 512)

It is quite certain that a machine that can make these things possible in one operation would be acceptable from the standpoint of conservation practices alone. At this time we are not in a position to state when we will have this machine on the market. I can say, nevertheless, that the main problems are fairly well under control and that the going is not quite so rough as it was when we started. Even though the remaining problems on this machine are in the cleaning-up stage, we realize that the benefits of this method of handling the nation's No. 1 crop should be made available at an early date—earlier than would be possible by the release of a completely new machine—and we have accordingly gone one step further. We have developed an attachment for conventional corn pickers that will result in essentially the same benefits from the conservation standpoint, as those derived from the complete new machine. During the past two seasons we have been applying our shredding experiences gained with the cutoff-type picker to the development of a unit that will operate in conjunction with a conventional corn picker. Our tests to date have been very satisfactory and that we are very hopeful of having this unit ready for application to conventional pickers in a relatively short time.

In conclusion, I wish to state we feel that both projects, the complete new machine and the attachment for application to a conventional picker, are of paramount importance and are receiving all the attention required to make them available at the earliest date possible.

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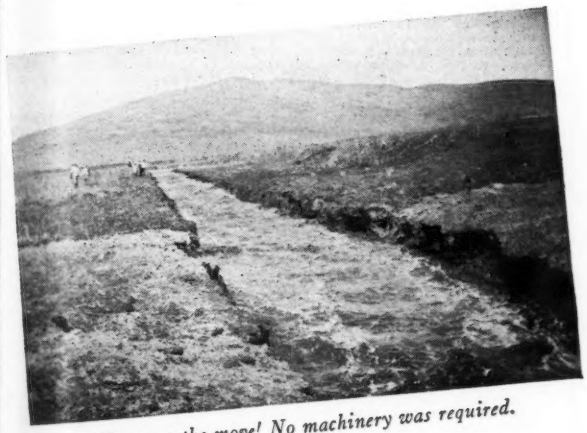

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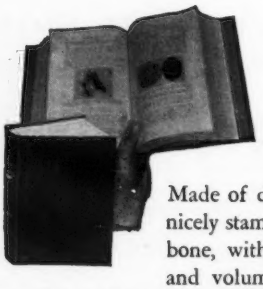

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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN: JUNE—0-355-717, 393-719, 407-721. JULY—0-360-722, 421-726. AUGUST—0-25-503, 25-504. SEPTEMBER—0-34-506.

POSITIONS WANTED: APRIL—W-294-368, 304-370, 291-373, 307-375. MAY—W-327-377, 333-380, 339-384, 349-385. JUNE—W-364-393, 384-395, 387-399, 274-400, 378-402, 354-403, 394-404. JULY—W-382-408, 337-409, 398-411, 414-412, 412-413, 410-414, 417-415. AUGUST—W-5-1, 4-2, 11-3, 26-5. SEPTEMBER—W-39-8, 38-9, 40-10, 48-11.

NEW POSITIONS OPEN

DESIGN ENGINEER for development work on tillage, planting, and cultivating implements in midwestern plant of a full-line manufacturer. BS deg in agricultural or mechanical engineering and at least 5 years experience in implement or similar mechanical design. Farm background and usual personal qualifications for commercial design. Salary open. 0-75-507

DESIGN ENGINEER for design of farm tractors and attachments with established company on the West Coast. BS deg in agricultural or mechanical engineering, or equivalent. Experience and background adequate to design either wheel or track-type tractors and usual attachments. Good opportunity for advancement. Age 35-45. Salary open. 0-76-508

DESIGN ENGINEER for design and development of sprayers, dusters, and various insecticide applicators, in eastern plant of a large manufacturer. BS deg in agricultural or mechanical engineering. Farm background and experience with power machinery. Must be able to cooperate and work with others. Excellent opportunity for advancement with a growing concern. Salary open. 0-46-509

NEW POSITIONS WANTED

DESIGN, development, research, or service in rural electric or product processing field, in public service or with manufacturer or processor, anywhere in U.S.A. BS deg in agricultural engineering, Michigan State College, 1948; MS deg in agricultural engineering, University of Minnesota, expected in December. Dairy farm background, Imperial Valley, Calif. Research assistant, University of Minnesota, 1948-50. Research engineer with USDA since January 1950, on farm buildings, rural housing, and grain storage investigations. War enlisted service over 4 years in Corps of Engineers, Quartermaster Corps, and Infantry. Married. Age 34. No disability. Available Nov. 15. Salary open. W-66-12

DESIGN, development, research, sales, or service in rural electric or soil and water field with distributor or trade association, preferably in North Central area. BS deg in agricultural engineering, South Dakota State College, 1950. Part time work 27 months in sales and service of electrical appliances. One year in irrigation research. War enlisted service in Signal Corps 1½ years. Married. Age 26. No disability. Available Jan. 1. Salary $3600. W-69-13

EXTENSION, teaching, sales, or service in rural electric or soil and water field with public service or industry, anywhere in U.S.A. Especially interested in sprinkler irrigation. BS deg in agricultural engineering, University of Maine, 1950. General farm background 18 years. Assistant manager in milk receiving plant one year. War enlisted and aviation cadet service 32 months. Married. Age 26. No disability. Available on two weeks notice. Salary open. W-73-14

EXTENSION or research in farm structures or soil and water field with a college in the West or Midwest. BS deg in agricultural engineering, Virginia Polytechnic Institute, 1940. Experience in heavy construction, manufacturing plants, 3 years; bridges, buildings, and sewers, 4 years. War enlisted service over 2 years in Army Engineers. Married. Age 33. No disability other than vision, corrected with glasses. Available on 20 days notice. Salary $4600. W-71-15